Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the South Atlantic Ocean, Austral Summer 2016

Submitted by

Lamont-Doherty Earth Observatory
61 Route 9W, P.O. Box 1000
Palisades, NY 10964-8000

to

National Marine Fisheries Service
Office of Protected Resources
1315 East–West Hwy, Silver Spring, MD 20910-3282

Application Prepared by

LGL Limited, environmental research associates
22 Fisher St., POB 280
King City, Ont. L7B 1A6

30 October 2015

LGL Report FA0051-2

TABLE OF CONTENTS

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SUMMARY

Researchers from Texas A&M University and the University of Texas, with funding from the U.S. National Science Foundation (NSF), propose to conduct a high-energy seismic survey on the Research Vessel (R/V) *Marcus G. Langseth* (*Langseth*) from the Mid-Atlantic Ridge (MAR) to the Rio Grande Rise in the South Atlantic Ocean for an approximate 42-day period in austral summer 2016. The NSF-owned *Langseth* is operated by Columbia University's Lamont-Doherty Earth Observatory (L-DEO) under an existing Cooperative Agreement. The proposed seismic survey would use a towed array of 36 airguns with a total discharge volume of ~6600 in^3. The survey would take place in International Waters in water depths 1150–4800 m. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371(a)(5).

Numerous species of marine mammals inhabit the South Atlantic Ocean. Several of these species are listed as ***Endangered*** under the ESA: the southern right, humpback, sei, fin, blue, and sperm whales. Other marine ESA-listed species that could occur in the area include the ***Endangered*** leatherback and hawksbill turtles; the ***Threatened*** green, loggerhead, and olive ridley turtles; the ***Endangered*** freira; and the ***Endangered*** scalloped hammerhead shark. ESA-listed ***candidate species*** that could occur in the area are the Argentine angelshark, angular angelshark, common thresher shark, porbeagle shark, narrownose smooth-hound shark, and Brazilian guitarfish.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, "Submission of Requests", are set forth below. They include descriptions of the specific operations to be conducted, the marine mammals occurring in the study area, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor any behavioral effects of the operations on those marine mammals.

I. OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

Overview of the Activity

The proposed survey would occur within the area ~10–35°W, 27–33°S (Fig. 1). Water depths in the survey area range from ~1150 to 4800 m. The proposed seismic survey would be conducted within International Waters of the South Atlantic Ocean. The survey is proposed to be conducted for ~42 days in austral summer 2016, with ~22 days of seismic operations.

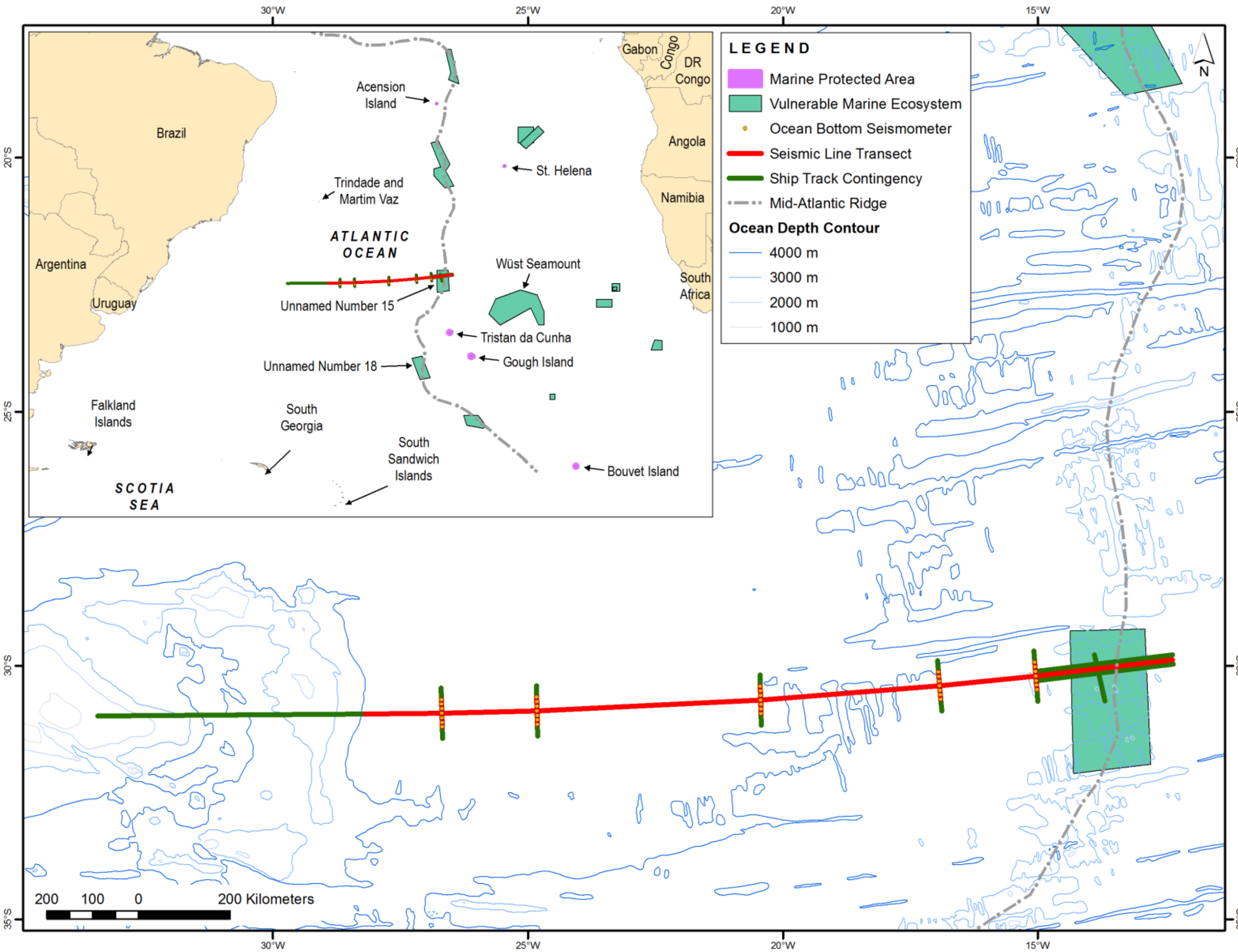

Figure 1. Location of the proposed seismic survey in the South Atlantic Ocean during austral summer 2016.

The procedures to be used for the survey would be similar to those used during previous seismic surveys by L-DEO and would use conventional seismic methodology. The main goal of the proposed research is to collect two-dimensional (2-D) seismic data from the MAR westward to the Rio Grande Rise to study the evolution of the South Atlantic Ocean crust on million-year timescales and the evolution and stability of low-spreading ridges over time. Multi-channel seismic (MCS) surveys and ocean bottom seismometer (OBS) profiles would be used to acquire reflection and refraction data, respectively. The collection of both reflection and refraction seismic data would provide for a continuous characterization of slow-to-intermediate spread oceanic crust from the active spreading center to crust formed (approximately) ~70 million years ago.

Additionally, the survey would provide essential International Ocean Discovery Program (IODP) site survey information for five proposed drill sites spanning the same transect; although information from the proposed activity would help inform the location of potential drill sites, should it go forward, the IODP activity would be an independent and separately funded activity. The resulting seismic data would address questions about the evolution of the ocean crust and the evolution and stability of slow-spreading ridges over time.

The goal of the MCS operations is to image changes in crustal structure from the MAR to aging crust to the west, as well as the increasing sedimentary cover and potential effects on crustal properties. The OBS profiles would acquire refraction data at five different sites with various half spreading rates: two with half spreading rates of 24–25 mm/year, two with 19.5 mm/year, and one with 15 mm/year. Profiles would be shot in the ridge-parallel direction to allow sampling of crust formed at the same age and at the same spreading rate along each line to characterize the structure of the crust and upper mantle. To achieve the project's goals, the Principal Investigator (PI) Dr. R. Reece (Texas A&M University) and co-PIs Drs. G. Christeson (University of Texas at Austin) and R. Carlson (Texas A&M University) propose to collect MCS reflection data along one main transect line between the MAR and Rio Grande Rise and five short crossline transects coincident with OBS profiles and the proposed IODP drill sites.

The survey would involve one source vessel, the *Langseth*, which is owned by NSF and operated on its behalf by L-DEO. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3. The receiving system would consist of seven OBSs deployed at each of five sites and a single 8-km hydrophone streamer. As the airgun array is towed along the survey lines, the OBSs would receive and store the returning acoustic signals internally for later analysis, and the hydrophone streamer would transfer the data to the on-board processing system.

A total of 3263 km of transect lines would be surveyed in the South Atlantic Ocean, including 2127 km of primary transect lines and 1136 km of contingency transect lines, if time allows (Fig. 1). There could be additional seismic operations associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated from the *Langseth* continuously throughout the survey. All planned geophysical data acquisition activity would be conducted by L-DEO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel.

Source Vessel Specifications

The R/V *Marcus G. Langseth* is described in § 2.2.2.1 of the Final Programmatic Environmental Impact Statement (PEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (NSF and USGS

2011) and Record of Decision (NSF 2012), referred to herein as the PEIS. The vessel speed during seismic operations would be 4.5 kt (~8.3 km/h).

Airgun Description

During the survey, the *Langseth* full array consisting of four strings with 36 airguns (plus 4 spares) and a total volume of ~6600 in^3, would be used. The airgun arrays are described in § 2.2.3.1 of the PEIS, and the airgun configurations are illustrated in Figures 2-11 to 2-13 of the PEIS. The 4-string array would be towed at a depth of 9 m; the shot intervals would range from 65 s (150 m) for OBS lines and ~22 s (50 m) for MCS surveying with the streamer.

Predicted Sound Levels

During the planning phase, mitigation zones for the proposed marine seismic survey were calculated based on modeling by L-DEO for both the exclusion and the safety zones. Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H in the PEIS), as a function of distance from the airguns, for the 36-airgun array at various tow depths and for a single 1900LL 40-in^3 airgun, which would be used during power downs. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (~1600 m), intermediate water depth on the slope (~600–1100 m), and shallow water (~50 m) in the Gulf of Mexico (GoM) in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep and intermediate-water cases, the field measurements cannot be used readily to derive mitigation radii, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 m, which may not intersect all the sound pressure level (SPL) isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of ~2000 m. Figures 2 and 3 in Appendix H of the PEIS show how the values along the maximum SPL line that connects the points where the isopleths attain their maximum width (providing the maximum distance associated with each sound level) may differ from values obtained along a constant depth line. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. The results are summarized below.

In deep and intermediate water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Fig. 12 and 14 in Appendix H of the PEIS). Consequently, isopleths falling within this domain can be predicted reliably by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At greater distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Fig. 11, 12, and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (~5 km in Fig. 11 and 12, and ~4 km in Fig. 16 in Appendix H of the PEIS) is where the observed levels rise closest to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Fig. 11, 12, and 16 in Appendix H of the PEIS). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for conservatively estimating mitigation radii.

The proposed survey would acquire data in deep water with the 36-airgun array at tow depth of 9 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m (Fig. 2). The isopleths calculated by the deep-water L-DEO model are essentially a measure of the energy radiated by the source array, where the 150-decibel (dB) Sound Exposure Level (SEL)[1] corresponds to an SPL of ~160 dB_{rms}, and 170 SEL corresponds to ~180 dB_{rms}.

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun fits under the low-energy source category in the PEIS. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applies an exclusion zone (EZ) of 100 m for all low-energy acoustic sources in water depths >100 m. This approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that would be used during power downs. L-DEO model results are used to determine the 160-dB_{rms} radius for the 40-in^3 airgun at 9-m tow depth in deep water (Fig. 3).

Table 1 shows the 180-and 190-dB re 1 μPa_{rms} EZs and 160-dB re 1 μPa_{rms} safety zone (distances at which the rms sound levels are expected to be received) for the 36-airgun array and the single (mitigation) airgun. The 180- and 190-dB distances are the safety criteria as specified by NMFS (2000) for cetaceans and pinnipeds, respectively. The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs.

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In July 2015, NOAA published a revised version of its 2013 draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2015), although at the time of preparation of this document, the date of release of the final guidelines and how they will be implemented are unknown. As such, this application has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as described in § XI.

OBS Description and Deployment

The *Langseth* would deploy seven OBSs at a 10-km spacing (with a total profile length of 60 km) at each of five sites. OBS operations would be carried out from west to east. For each of the five OBS profiles, seven OBSs would be deployed followed by the source array, the line would be surveyed, and the source array and OBSs would then be recovered before moving to the next line. It is proposed that the hydrophone streamer and airgun array would be deployed for MCS operations from east to west after all OBS operations are finished. However, MCS surveying may occur before OBS operations.

The OBSs that would be used during the cruise could include Woods Hole Oceanographic Institute (WHOI) and Scripps Institution of Oceanography (SIO) OBSs. The WHOI D2 OBSs have a height of ~1 m and a maximum diameter of 50 cm. The anchor is made of hot-rolled steel and weighs 23 kg. The anchor dimensions are 2.5 × 30.5 × 38.1 cm. The SIO L-Cheapo OBSs have a height of ~0.9 m and a maximum diameter of 97 cm. The anchors are 36-kg iron grates with dimensions 7 × 91 × 91.5 cm.

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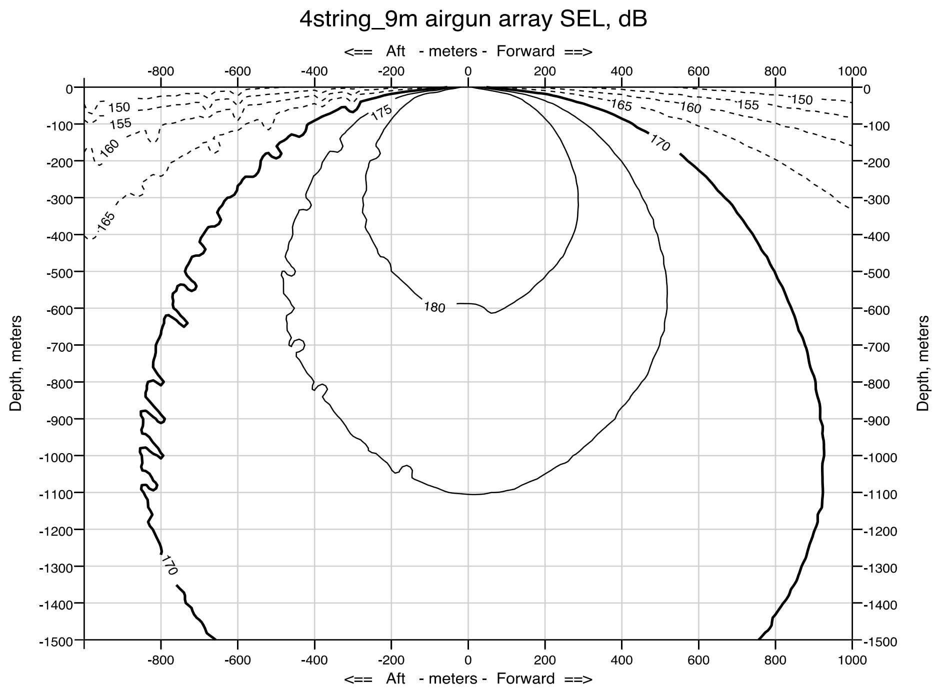
[1] SEL (measured in dB re 1 $\mu Pa^2 \cdot s$) is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the SEL value for a given pulse is usually lower than the SPL calculated for the actual duration of the pulse. In this EA, we assume that rms pressure levels of received seismic pulses would be 10 dB higher than the SEL values predicted by L-DEO's model.



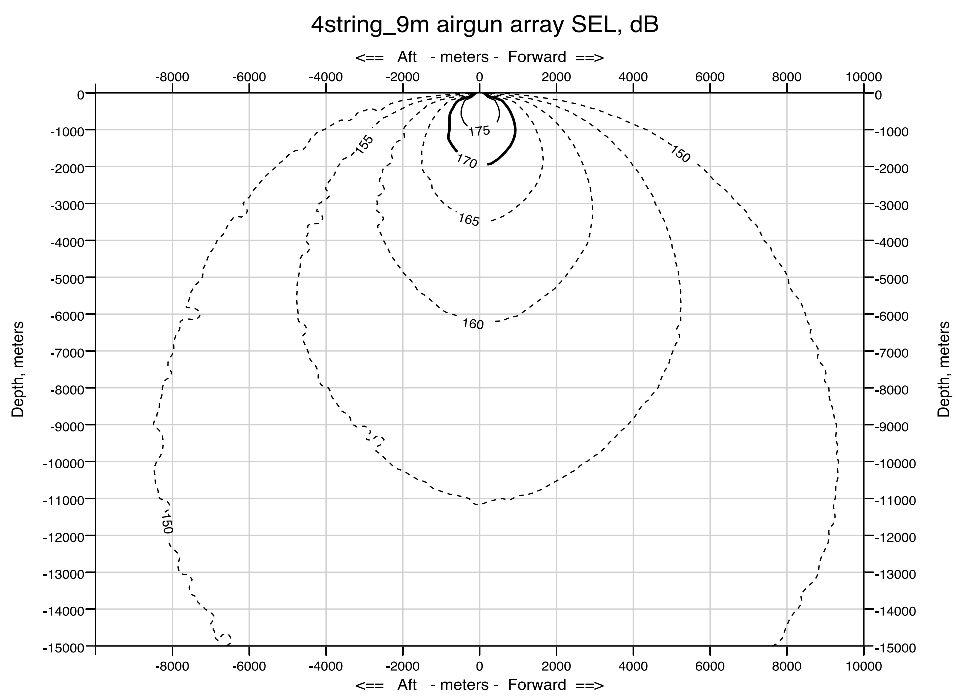
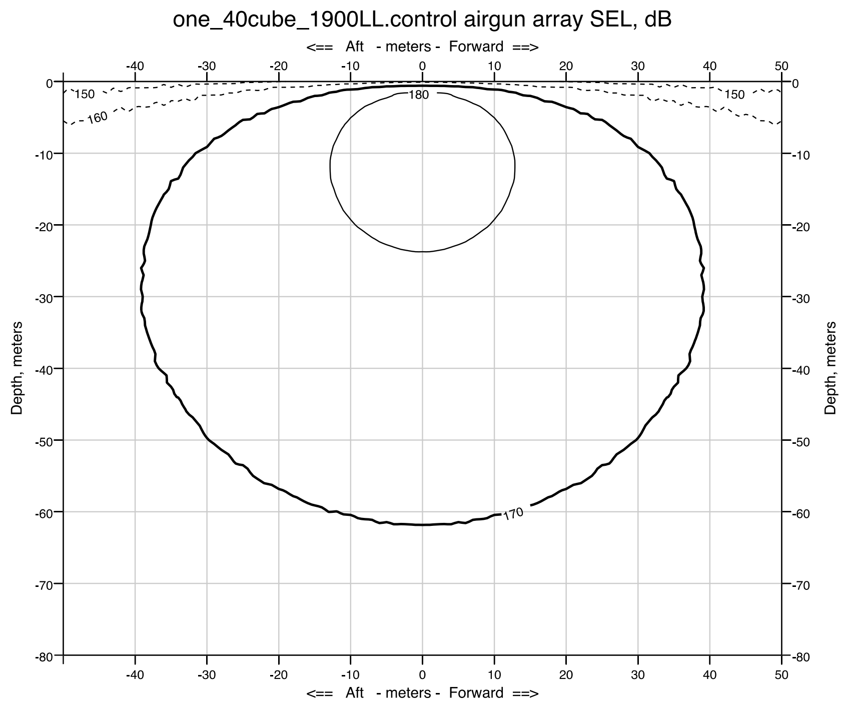


FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the proposed survey in the South Atlantic Ocean at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.



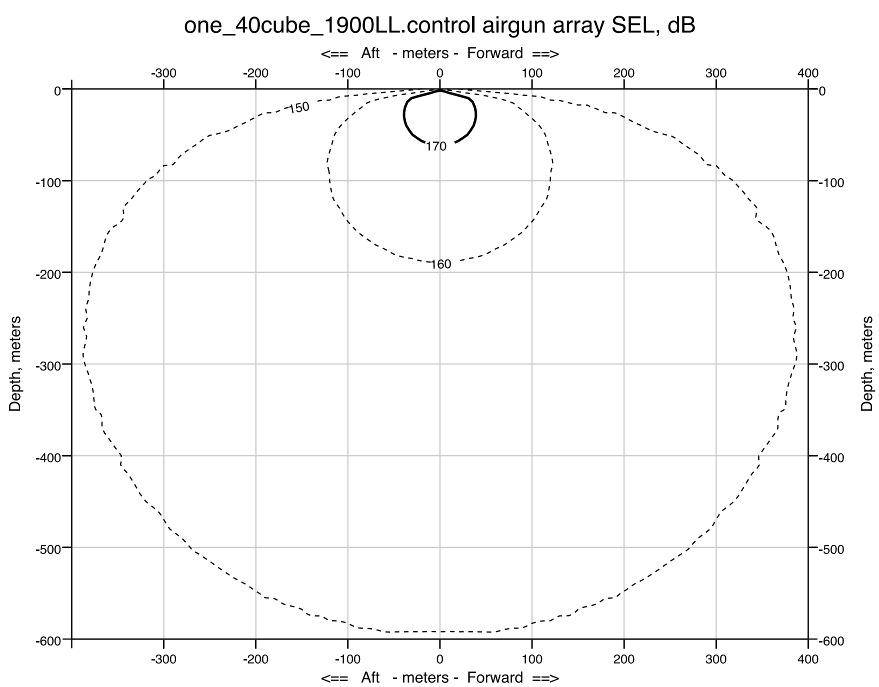


FIGURE 3. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9-m depth, which is planned for use as a mitigation gun during the proposed survey in the South Atlantic. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleths as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

TABLE 1. Predicted distances to which sound levels ≥190-, 180-, and 160-dB re 1 μPa_{rms} are expected to be received during the proposed survey in the South Atlantic Ocean. For the single mitigation airgun, the EZ is the conservative EZ for all low-energy acoustic sources in water depths >100 m defined in the PEIS.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted rms Radii (m)		
			190 dB	180 dB	160 dB
Single Bolt airgun, 40 in^3	9	>1000 m	100	100	388
4 strings, 36 airguns, 6600 in^3	9	>1000 m	286	927	5780

Once an OBS is ready to be retrieved, an acoustic release transponder interrogates the instrument at a frequency of 8–11 kHz, and a response is received at a frequency of 11.5–13 kHz. The burn-wire release assembly is then activated, and the instrument is released from the anchor to float to the surface.

Description of Operations

The procedures to be used for the marine geophysical survey would be similar to those used during previous surveys by L-DEO and would use conventional seismic methodology. The survey would involve one source vessel, the *Langseth*. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3. The receiving system would consist of seven OBSs deployed at each of five sites and a single 8-km hydrophone streamer. As the airgun array is towed along the survey lines, the OBSs would receive and store the returning acoustic signals internally for later analysis, and the hydrophone streamer would transfer the data to the on-board processing system.

A total of 3263 km of transect lines would be surveyed in the South Atlantic Ocean, including 2127 km of primary transect lines and 1136 km of contingency transect lines, if time allows (Fig. 1). There could be additional seismic operations associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations. In addition to the operations of the airgun array, the ocean floor would be mapped with a Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. These sources are described in § 2.2.3.1 of the PEIS.

II. DATES, DURATION, AND REGION OF ACTIVITY

The date(s) and duration of such activity and the specific geographical region where it will occur.

The proposed survey would occur within the area ~10–35°W, 27–33°S (Fig. 1). Water depths in the survey area range from ~1150 to 4800 m. The proposed seismic survey would be conducted within International Waters of the South Atlantic Ocean.

The survey is proposed to be conducted for ~42 days in austral summer 2016. The seismic program would take ~32 days, including ~22 days of seismic surveying and 10 days of OBS deployment/retrieval. The *Langseth* would depart from and return to Montevideo, Uruguay; round-trip transit from port to the proposed survey area would be ~10 days. Some deviation in the schedule and port locations are possible, depending on logistics and weather. A change in the survey timing, including to a different season, would not affect the ensuing analysis (including take estimates), because the best available species densities for any time of the year have been used.

III. Species and Numbers of Marine Mammals in Area

The species and numbers of marine mammals likely to be found within the activity area

Forty species of cetaceans (9 mysticetes and 31 odontocetes) and 2 pinniped species could potentially occur in the offshore waters of the proposed survey area in the South Atlantic Ocean. To avoid redundancy, we have included the required information about the species and (insofar as it is known) numbers of these species in § IV, below.

IV. Status, Distribution and Seasonal Distribution of Affected Species or Stocks of Marine Mammals

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities

Sections III and IV are integrated here to minimize repetition.

Of the 42 marine mammal species that could potentially occur in the offshore waters of the proposed survey area in the South Atlantic Ocean, six are listed under the U.S. Endangered Species Act (ESA) as ***Endangered***: the southern right, humpback, fin, sei, blue, and sperm whales. General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals is given in § 3.6.1, § 3.7.1, and § 3.8.1 of the PEIS. The general distributions of marine mammals in the southwestern Atlantic Ocean are discussed in the PEIS in § 3.6.3.3 for mysticetes, § 3.7.3.3 for odontocetes, and § 3.8.3.3 for pinnipeds. The rest of this section deals with species distribution in the proposed offshore survey area across the MAR in the South Atlantic Ocean.

Information on the occurrence near the proposed survey area, habitat, population size, and conservation status for each of the 42 marine mammal species is presented in Table 2. Although an additional 20 species of marine mammals are known to occur in the South Atlantic Ocean, they are unlikely to occur within the proposed survey area because they have more coastal distributions in the South Atlantic (e.g., spectacled porpoise *Phocoena dioptrica*, Burmeister's porpoise *Phocoena spinipinnis*, Franciscana *Pontoporia blainvillei*, Guiana dolphin *Sotalia guianensis*, Atlantic humpback dolphin *Sousa teuszii*, Peale's dolphin *Lagenorhynchus australis*, Commerson's dolphin *Cephalorhynchus commersonii*, Heaviside's dolphin *Cephalorhynchus heavisidii*, long-beaked common dolphin *Delphinus capensis*, Atlantic spotted dolphin *Stenella frontalis*, dusky dolphin *Lagenorhynchus obscurus*, Risso's dolphin *Grampus griseus*, South American sea lion *Otaria flavescens*, South American fur seal *Arctocephalus australis*, and South African fur seal *Arctocephalus pusillus*), or their distributional range is farther south (e.g., leopard seal *Hydrurga leptonyx*, crabeater seal *Lobodon carcinophaga*, Ross seal *Ommatophoca rossii*, Weddell seal *Leptonychotes weddellii*, and Antarctic fur seal *Arctocephalus gazella*). Although extralimital records of a leopard seal and several Antarctic fur seals exist for Gough Island (Wilson et al. 2006), none of the aforementioned species are discussed further here.

Mysticetes

Southern Right Whale (*Eubalaena australis*)

The southern right whale occurs throughout the Southern Hemisphere between ~20°S and 60°S (Kenney 2009), although in areas where cold water currents extend northwards, it may occur farther north(Best 2007). It migrates between summer foraging areas at high latitudes and winter breeding/calving areas in

TABLE 2. The habitat, occurrence, regional population sizes, and conservation status of marine mammals that could occur in or near the proposed survey area in the South Atlantic Ocean.

Species	Occurrence	Habitat	Population Size	ESA[1]	IUCN[2]	CITES[3]
Mysticetes						
Southern right whale	Rare	Coastal, shelf	12,000[4]	EN	LC	I
Pygmy right whale	Rare	Coastal, pelagic	N.A.	NL	DD	I
Humpback whale	Rare	Coastal, shelf, pelagic	42,000[4]	EN[5]	LC	I
Common (dwarf) minke whale	Rare	Shelf, pelagic	515,000[4,6]	NL	LC	I
Antarctic minke whale	Rare	Shelf, pelagic	515,000[4,6]	NL	DD	I
Bryde's whale	Rare	Coastal, pelagic	48,109[7]	NL	DD	I
Sei whale	Uncommon	Shelf edges, pelagic	10,000[8]	EN	EN	I
Fin whale	Uncommon	Coastal, pelagic	15,000[8]	EN	EN	I
Blue whale	Rare	Coastal, shelf, pelagic	2300 true[4]; 1500 pygmy[8]	EN	EN	I
Odontocetes						
Sperm whale	Uncommon	Slope, pelagic	10,500[9]	EN	VU	I
Dwarf sperm whale	Rare	Shelf, slope, pelagic	N.A.	NL	DD	II
Pygmy sperm whale	Rare	Shelf, slope, pelagic	N.A.	NL	DD	II
Cuvier's beaked whale	Uncommon	Slope	599,300[10]	NL	LC	II
Arnoux's beaked whale	Rare	Pelagic	599,300[10]	NL	DD	I
Shepherd's beaked whale	Rare	Pelagic	N.A.	NL	DD	II
Southern bottlenose whale	Rare	Pelagic	599,300[10]	NL	LC	I
Hector's beaked whale	Rare	Pelagic	N.A.	NL	DD	II
True's beaked whale	Rare	Pelagic	N.A.	NL	DD	II
Gervais' beaked whale	Rare	Pelagic	N.A.	NL	DD	II
Gray's beaked whale	Rare	Pelagic	599,300[10]	NL	DD	II
Andrew's beaked whale	Rare	Pelagic	N.A.	NL	DD	II
Strap-toothed beaked whale	Rare	Pelagic	599,300[10]	NL	DD	II
Blainville's beaked whale	Rare	Slope, pelagic	N.A.	NL	DD	II
Spade-toothed beaked whale	Rare	Pelagic	N.A.	NL	DD	II
Rough-toothed dolphin	Uncommon	Shelf, pelagic	N.A.	NL	LC	II
Common bottlenose dolphin	Uncommon	Coastal, pelagic	600,000[11]	NL	LC	II
Pantropical spotted dolphin	Uncommon	Coastal, slope, pelagic	N.A.	NL	LC	II
Spinner dolphin	Rare	Coastal, pelagic	N.A.	NL	DD	II
Clymene dolphin	Rare	Pelagic	N.A.	NL	DD	II
Striped dolphin	Rare	Mainly pelagic	N.A.	NL	LC	II
Fraser's dolphin	Uncommon	Pelagic	N.A.	NL	LC	II
Short-beaked common dolphin	Uncommon	Coastal, pelagic	N.A.	NL	LC	II
Hourglass dolphin	Rare	Pelagic	150,000[8]	NL	LC	II
Southern right whale dolphin	Uncommon	Pelagic	N.A.	NL	DD	II
Melon-headed whale	Rare	Pelagic	N.A.	NL	LC	II
Pygmy killer whale	Uncommon	Pelagic	N.A.	NL	DD	II
False killer whale	Rare	Pelagic	N.A.	NL	DD	II
Killer whale	Rare	Coastal, pelagic	25,000[12]	NL	DD	II
Long-finned pilot whale	Uncommon	Shelf, slope, pelagic	200,000[8]	NL	DD	II
Short-finned pilot whale	Uncommon	Pelagic	N.A.	NL	DD	II
Pinnipeds						
Subantarctic fur seal	Rare	Coastal, pelagic	>310,000[13]	NL	LC	II
Southern elephant seal	Rare	Coastal, pelagic	640,000[14]	NL	LC	II

N.A. = Data not available
[1] U.S. Endangered Species Act (NMFS 2015a): EN = Endangered; NL = Not Listed
[2] Classification from the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2015): EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2015): Appendix I = Threatened with extinction; Appendix II = not necessarily now threatened with extinction but may become so unless trade is closely controlled
[4] Southern Hemisphere (IWC 2015)
[5] NMFS has recently (April 2015) proposed that 14 distinct population segments (DPSs) of humpback whales should be recognized and that 10 of those should be delisted, including the Brazil and Gabon/Southwest Africa DPSs (NMFS 2015b)

[6] Dwarf and Antarctic minke whales combined
[7] Southern Hemisphere (IWC 1981)
[8] Antarctic (Boyd 2002)
[9] Estimate for the Antarctic, south of 60°S (Whitehead 2002)
[10] All beaked whales south of the Antarctic Convergence; mostly southern bottlenose whales (Kasamatsu and Joyce 1995)
[11] Worldwide estimate (Wells and Scott 2009)
[12] Minimum estimate for Southern Ocean (Ford 2009)
[13] Total world population (Arnould 2009)
[14] Total world population (Hindell and Perrin 2009)

low latitudes (Kenney 2009). However, migration routes from foraging areas to nursery and feeding grounds are not well known (Best et al. 1993).

Based on available data, the current distributional range of southern right whales in the South Atlantic Ocean does not appear to extend as far north as the proposed survey area; however, survey effort in pelagic waters of this region has been limited (Kenney 2009). In the South Atlantic, breeding areas are known to occur or have occurred historically in the shallow coastal waters of South America, including Argentina and Brazil, as well as the Falkland Islands, Tristan de Cunha, Namibia, and South Africa (IWC 2001). Right whales occurring in breeding and nursing grounds of southern Brazil and the Península Valdés, Argentina, possibly comprise two separate subpopulations that exploit different habitats; feeding also occurs at these grounds (Vighi et al. 2014). Waters south of South Africa are believed to be a nursery area, as females and calves are sighted there, whereas waters off western South Africa might currently be used as a year-round feeding area (Barendse and Best 2014). The highest sighting rates off western South Africa occur during early austral summer, and the lowest rates have been reported from autumn to mid winter (Barendse and Best 2014).

Although southern right whale calving/breeding areas are located in nearshore waters, feeding grounds in the Southern Ocean apparently are located mostly in pelagic waters (Kenney 2009). Travel by right whales from the coasts of South America and Africa to the waters of the mid-Atlantic have been documented (Best et al. 1993; Rowntree et al. 2001; Mate et al. 2011). Based on photo-identification work, right whales were reported to have traveled between Gough Island and South Africa, and from Argentina to Tristan da Cunha (Best et al. 1993). Adult right whales at Gough Island were sighted on 10 September 1983, and two adult whales and a calf were observed at Tristan da Cunha on 14 October 1989 (Best et al. 1993). Six right whale sightings were also made in Tristan waters from August to October 1971 (Best and Roscoe 1974). Right whales were also documented to travel from feeding areas off Argentina to South Georgia (Best et al. 1993) and Shag Rocks (Moore et al. 1999). Thus, there is potential for mixing of populations between calving grounds on either side of the South Atlantic Ocean, and at foraging areas near South Georgia (Best et al. 1993; Best 2007; Patenaude et al. 2007).

In September 2001, 21 right whales were equipped with radio tags in South Africa (Mate et al. 2011). Five of them migrated southward to waters southeast of Gough Island, Bouvet Island, and beyond (Mate et al. 2011). Four satellite-tagged whales traveled into St. Helena Bay on the west coast of South Africa; this might be a feeding area (Mate et al. 2011). Other tagged whales moved southward and appeared to remain near the Subtropical Convergence and Antarctic Polar Front, presumably to feed (Mate et al. 2011). In the first two weeks after five southern right whales were tagged during October–November 2014 at nursery grounds off Península Valdés, Argentina, three young males moved southeastward into offshore waters, and two females with calves remained close to the coast (IWC 2014). Subsequently, one young male moved towards the Sandwich Islands, the other two young males were reported in shelf waters off Argentina, and one female with a calf moved northeastward off the shelf (EVOTIS 2015).

Best et al. (2009) also reported southern right whale sightings and catches in the Tristan da Cunha archipelago. From 1983 to 1991, 75 sightings totaling 116 right whales were observed during aerial surveys of Tristan waters (Best et al. 2009). One sighting was made off Inaccessible Island; all others were made at Tristan Island (Best et al. 2009). The majority of sightings occurred during September–October, but sightings were also made during April, June–August, and November–December (Best et al. 2009). This region is likely an oceanic nursing area for the right whale (Best et al. 2009). Additionally, a single southern right whale has been reported for waters near St. Helena (Clingham et al. 2013).

Historically, right whale catches were made between 30 and 40°S, from the coast of Africa to the coast of South America; most catches were made from October to January at whaling grounds including the Tristan and Pegeon grounds, and False and Brazil banks (Townsend 1935 *in* Best et al. 1993; Best et al. 2009). Right whale catches were also made at the Tristan da Cunha archipelago from 1951 to 1971 by Soviet fleets (Tormosov et al. 1998). There are ~3800 records of southern right whales for the South Atlantic in the Ocean Biogeographic Information System (OBIS) database, including nearshore and offshore waters (OBIS 2015). Most records (2511) are from historical catch data; 20 catches occurred near the proposed survey area, at 30–32°S, 12–28°W (Townsend 1931, 1935 *in* OBIS 2015).

High mortalities in southern right whales calves have been documented at Península Valdés since 2003 (Rowntree et al. 2013). During 2003–2011, a total of 482 right whale mortalities have been reported, 89% of which were calves; in 2012, 116 whales were found stranded (Rowntree et al. 2013). To date, at least 672 southern right whales have died at Península Valdés (IWC 2014). It is uncertain at this time what is causing these high mortality rates, but disease, nutritional stress, biotoxins, contaminants, and/or gull harassment could be explanatory variables (Rowntree et al. 2013).

Pygmy Right Whale (*Caperea marginata*)

The distribution of the pygmy right whale is circumpolar in the Southern Hemisphere between 30°S and 55°S in oceanic and coastal environments (Jefferson et al. 2008; Kemper 2009). The pygmy right whale appears to be non-migratory, although there may be some movement inshore in spring and summer (Kemper 2002; Jefferson et al. 2008). Foraging areas are not known, but it seems likely that pygmy right whales may feed at productive areas in higher latitudes, such as near the Subtropical Convergence (Best 2007).

In the South Atlantic, pygmy right whale records exist for southern Africa, South America, the Falkland Islands, and pelagic waters (Baker 1985). Bester and Ryan (2007) suggested that pygmy right whales occur in the Tristan da Cunha archipelago. One was taken by whalers at 35°S and 8°W on 30 November 1970 (Budylenko et al. 1973 *in* Best et al. 2009). The waters of the proposed survey area are considered part of the pygmy right whale's secondary range (Jefferson et al. 2008). There are no OBIS records of pygmy right whales for the offshore waters of the proposed survey area, but 10 records exist off southwestern Africa (OBIS 2015).

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is found in all ocean basins (Clapham 2009). Based on recent genetic data, there could be three subspecies, occurring in the North Pacific, North Atlantic, and Southern Hemisphere (Jackson et al. 2014). The humpback whale is highly migratory, traveling between mid- to high-latitude waters where it feeds during spring to fall and low-latitude wintering grounds over shallow banks, where it calves (Winn and Reichley 1985). Although considered to be mainly a coastal species, it often traverses deep pelagic areas while migrating (Baker et al. 1998; Garrigue et al. 2002; Zerbini et al. 2011).

In the Southern Hemisphere, humpback whales migrate annually from summer foraging areas in the Antarctic to breeding grounds in tropical seas (Clapham 2009). The International Whaling Commission (IWC) recognizes seven breeding populations in the Southern Hemisphere that are linked to six foraging areas in the Antarctic (Clapham 2009). Two of the breeding grounds are in the South Atlantic: one off Brazil and another off West Africa (Engel and Martin 2009). Bettridge et al. (2015) have identified humpback whales at these breeding locations as the Brazil and Gabon/Southwest Africa DPSs.

Breeding stock 'A' consists of whales that occur between ~5°S and 23°S in the coastal waters off Brazil; this population was estimated at 6404 individuals (e.g., Andriolo et al. 2010). It appears to be most abundant at Abrolhos Bank, which is the main breeding area for the humpback in the western South Atlantic (e.g., Martins et al. 2001; Andriolo et al. 2006, 2010). Humpbacks start aggregating in this area in June, and most have migrated southward by November (Engel and Martin 2009), although some depart as late as December (Zerbini et al. 2011). Whales migrating southward from Brazil have been shown to traverse offshore, pelagic waters within a narrow migration corridor (Zerbini et al. 2006, 2011) en route to feeding areas along the Scotia Sea, including the waters around Shag Rocks, South Georgia, and the South Sandwich Islands (Stevick et al. 2006; Zerbini et al. 2006, 2011; Engel et al. 2008; Engel and Martin 2009).

The southeastern Atlantic breeding stock 'B' occurs off western Africa (Rosenbaum et al. 2009; Carvalho et al. 2011). There may be two breeding substocks in this area, including individuals in the main breeding area in the Gulf of Guinea and those animals migrating past South Africa (Carvalho et al. 2011). In addition, wintering humpbacks have also been reported on the continental shelf of northwest Africa, which may represent the northernmost humpback whales that are known to winter in the Gulf of Guinea (Van Waerebeek et al. 2013). The west coast of South Africa might not be a 'typical' migration corridor, as humpbacks are also known to feed in the area; they are known to occur in the region during the northward migration (July–August), the southward migration (October–November), and into February (Barendse et al. 2010; Carvalho et al. 2011). The highest sighting rates in the area occurred during mid spring through summer (Barendse et al. 2010).

Humpbacks have been seen on breeding grounds around São Tomé in the Gulf of Guinea from August through November; off Gabon, whales occur from late June to December (Carvalho et al. 2011). Feeding areas for this stock include Bouvet Island (Rosenbaum et al. 2014) and waters of the Antarctic Peninsula (Barendse et al. 2010). Based on whales that were satellite-tagged in Gabon in winter 2002, migration routes southward include offshore waters along Walvis Ridge (Rosenbaum et al. 2014). Migration rates were relatively high between populations within the southeastern Atlantic (Rosenbaum et al. 2009). Genetic studies also showed evidence of migration between the southwestern and southeastern Atlantic stocks (Rosenbaum et al. 2009). In fact, similarities in humpback whale songs have been demonstrated between Brazil and Gabon (Darling and Sousa-Lima 2005). Genetic data also showed relatively high effective migration rates between western and eastern Africa (Rosenbaum et al. 2009). Based on photo-identification work, one female humpback whale traveled from Brazil to Madagascar, a distance of >9800 km (Stevick et al. 2011). Deoxyribonucleic acid (DNA) sampling showed evidence of a male humpback having traveled from western Africa to Madagascar (Pomilla and Rosenbaum 2005).

Humpbacks occur occasionally around the Tristan da Cunha archipelago (Bester and Ryan 2007). Three records exist for Tristan waters, all south of 37°S (Best et al. 2009). Humpback whales have also been sighted off St. Helena (MacLeod and Bennett 2007; Clingham et al. 2013). Numerous humpbacks were detected visually and acoustically during a survey off Brazil from Vitória at ~20°S, 40°W, to Trindade and Martim Vaz islands during August–September 2010 (Wedekin et al. 2014). One adult humpback was seen on 31 August near Trindade Island, at 20.5°S, 29.3°W in a water depth of 150 m, but no acoustic detections were made east of 35°W (Wedekin et al. 2014). Numerous sightings were also made near Trindade Island during July–August 2007 and before that date (Siciliano et al. 2012).

The waters of the proposed survey area are considered part of the humpback's secondary range (Jefferson et al. 2008). For the South Atlantic, the OBIS database shows numerous sightings along the coasts of South America and Africa, at least 9 records for areas >1000 km offshore, and two records near the proposed survey area (OBIS 2015). Two sightings were made at 30.8°S, 17.2°W during August and October of 1910 during the British Antarctic Expedition; the next nearest sighting was reported at 25.1°S, 25.8°W, ~900 km north of the survey line (Southwestern Pacific OBIS 2014).

Common Minke Whale (*Balaenoptera acutorostrata*)

The common minke whale has a cosmopolitan distribution ranging from the tropics and sub-tropics to the ice edge in both hemispheres (Jefferson et al. 2008). A smaller form (unnamed subspecies) of the common minke whale, known as the dwarf minke whale, occurs in the Southern Hemisphere, where its distribution overlaps with that of the Antarctic minke whale (*B. bonaerensis*) during summer (Perrin and Brownell 2009). The dwarf minke whale is generally found in shallower coastal waters and over the shelf in regions where it overlaps with *B. bonaerensis* (Perrin and Brownell 2009). The range of the dwarf minke whale is thought to extend as far south as 65°S (Jefferson et al. 2008) and as far north as 2°S in the Atlantic off South America, where it can be found nearly year-round (Perrin and Brownell 2009). It is known to occur off South Africa during autumn and winter (Perrin and Brownell 2009) and likely occurs in the waters of the Tristan da Cunha archipelago (Bester and Ryan 2007).

The waters of the proposed survey area are considered to be within the possible range of the common (dwarf) minke whale, with the primary range occurring in nearshore and offshore waters of South America and along the coast of southwestern Africa (Jefferson et al. 2008). There are no OBIS records of common minke whales for the offshore waters of the proposed survey area, but 30 records exist for nearshore waters of the South Atlantic along the coasts of South America and Africa (OBIS 2015).

Antarctic Minke Whale (*Balaenoptera bonaerensis*)

The Antarctic minke whale has a circumpolar distribution in coastal and offshore areas of the Southern Hemisphere from ~7°S to the ice edge (Jefferson et al. 2008). It is found between 60°S and the ice edge during the austral summer; in the austral winter, it is mainly found at mid-latitude breeding grounds, including off western South Africa and northeastern Brazil, where it is primarily oceanic, occurring beyond the shelf break (Perrin and Brownell 2009).

Antarctic minke whales are also likely to occur in the Tristan da Cunha archipelago (Bester and Ryan 2007). Two groups totaling seven whales were sighted at 36.4°S, 8.5°W on 7 October 1988 (Best et al. 2009). A sighting of two Antarctic minke whales was made off Brazil during an August–September 2010 survey from Vitória, at ~20°S, 40°W, to Trindade and Martim Vaz islands; the whales were seen in association with a group of rough-toothed dolphins near 19.1°S, 35.1°W on 21 August (Wedekin et al. 2014). There are no OBIS records of Antarctic minke whales for the offshore waters of the proposed survey area, but three records exist for nearshore waters of the South Atlantic along the coasts of South America and Africa (OBIS 2015).

Bryde's Whale (*Balaenoptera edeni/brydei*)

Bryde's whale occurs in all tropical and warm temperate waters in the Pacific, Atlantic, and Indian oceans, between 40°N and 40°S (Kato and Perrin 2009). It is one of the least known large baleen whales, and it remains uncertain how many species are represented in this complex (Kato and Perrin 2009).

B. brydei is commonly used to refer to the larger form or "true" Bryde's whale and *B. edeni* to the smaller form; however, some authors apply the name *B. edeni* to both forms (Kato and Perrin 2009; Rudolph and Smeenk 2009). The smaller form is restricted to coastal waters (Rudolph and Smeenk 2009). Bryde's whale remains in warm (>16°C) water year-round, and seasonal movements have been recorded towards the Equator in winter and offshore in summer (Kato and Perrin 2009). It is frequently observed in biologically productive areas such as continental shelf breaks (Davis et al. 2002) and regions subjected to coastal upwelling (Gallardo et al. 1983; Siciliano et al. 2004).

In the South Atlantic, Bryde's whale is known to occur in the waters off Brazil (e.g., Siciliano et al. 2004) and southern Africa (e.g., Best 2001). Three populations of Bryde's whales have been proposed for the waters off southern Africa, including the South African Inshore Stock, the pelagic Southeast Atlantic Stock, and the Southwest Indian Ocean Stock, which is restricted to the Indian Ocean (Best 2001). The pelagic waters of the Atlantic Ocean are considered part of the Bryde's whale's secondary range (Jefferson et al. 2008). A Bryde's whale was sighted in the offshore waters of the South Atlantic during a cruise from Spain to South Africa in November 2009, near 22°S, 6°W (Shirshov Institut n.d.), >1000 km from the proposed survey area. In the OBIS database, there are no records for the offshore waters of the proposed survey area, but there are 12 records at the Iziko South African Museum (OBIS 2015).

Sei Whale (*Balaenoptera borealis*)

The sei whale occurs in all ocean basins (Horwood 2009). It undertakes seasonal migrations to feed in sub-polar latitudes during summer, returning to lower latitudes during winter to calve (Horwood 2009). In the Southern Hemisphere, sei whales typically concentrate between the Subtropical and Antarctic convergences during the summer (Horwood 2009).

Twenty sightings of sei whales were made in the coastal waters of Argentina and in the Falkland Islands from 2004 to 2008, with the majority of sightings during August–September (Iñíguez et al. 2010). A group of 2–4 sei whales was seen near St. Helena during April 2011 (Clingham et al. 2013). Although the occurrence of sei whales is likely in the Tristan da Cunha archipelago (Bester and Ryan 2007), there have been no recent records of sei whales in the region; however, sei whale catches were made here in the 1960s (Best et al. 2009). Sei whales were also taken off southern Africa during the 1960s, with some catches reported just to the southeast of the proposed survey area; catches were made during the May–July northward migration as well as during the August–October southward migration (Best and Lockyer 2002).

There is one sei whale record in the OBIS database near the proposed survey area, and two additional records for waters to the east of the proposed survey area (OBIS 2015). The sighting near the proposed survey area was made at 30.8°S and 17.2°W in August 1910 during the British Antarctic Expedition; the next nearest sighting was reported for 33.3°S and 8.0°W, ~900 km north of the survey line (Southwestern Pacific OBIS 2014). One more sighting was reported for 35.1°S and 6.4°W by the United Kingdom (U.K.) Royal Navy (Maughan 2003).

Fin Whale (*Balaenoptera physalus*)

The fin whale is widely distributed in all the world's oceans (Gambell 1985), although it is most abundant in temperate and cold waters (Aguilar 2009). Nonetheless, its overall range and distribution is not well known (Jefferson et al. 2008). Fin whales most commonly occur offshore, but can also be found in coastal areas (Aguilar 2009). Most populations migrate seasonally between temperate waters where mating and calving occur in winter, and polar waters where feeding occurs in the summer; they are known to use the shelf edge as a migration route (Evans 1987). Sergeant (1977) suggested that fin whales tend to follow steep slope contours, either because they detect them readily, or because the contours are areas of high biological productivity. However, fin whale movements have been reported to be complex, and not all populations follow this simple pattern (Jefferson et al. 2008).

In the Southern Hemisphere, fin whales are typically distributed south of 50ºS in the austral summer, and they migrate northward to breed in the winter (Gambell 1985). Fin whales appear to be somewhat common in the Tristan da Cunha archipelago from October to December (Bester and Ryan 2007). Historical whaling data also show several catches for this area (Best et al. 2009) and off southern Africa (Best 2007). Several sightings were made off western South Africa during November 2009; one sighting was reported near 30°S and 2°E, and several other sightings were made near 35°S and 11°E (Shirshov Institute n.d.). Forty fin whales were seen during a transatlantic voyage along 20°S during August 1943 between 5° and 25°W (Wheeler 1946 *in* Best 2007).

A group of two fin whales was sighted during an August–September 2010 survey off Brazil from Vitória at ~20°S, 40°W to Trindade and Martim Vaz islands; the group was seen at Trindade Island, near 20.5°S, 29.3°W, on 31 August (Wedekin et al. 2014). There are no OBIS records of fin whales for the offshore waters of the proposed survey area, but 15 records exist in the South Atlantic for the nearshore waters along the coasts of South America and Africa (OBIS 2015).

Blue Whale (*Balaenoptera musculus*)

The blue whale has a cosmopolitan distribution, but tends to be mostly pelagic, only occurring nearshore to feed and possibly breed (Jefferson et al. 2008). *B.m. intermedia* (the true blue whale) occurs in the Antarctic and *B.m. brevicauda* (the pygmy blue whale) inhabits the sub-Antarctic zone (Sears and Perrin 2009). However, it is uncertain whether the pygmy whale occurs in the South Atlantic Ocean; no confirmed sightings or acoustic detections have been made in this region (Branch et al. 2007). The Antarctic blue whale is typically found south of 55°S during summer, although some are known not to migrate (Branch et al. 2007).

An extensive data review and analysis by Branch et al. (2007) showed that blue whales are essentially absent from the central regions of major ocean basins, including the South Atlantic. No sightings or catches were made near the proposed survey area, although a handful of blue whales were landed off the coasts of South America and Africa; most catches occurred in the waters of the Southern Ocean during January–March (Branch et al. 2007). In addition, there are very few reports of blue whales for the southwest Atlantic, only scattered records for Brazil, Uruguay, and Argentina (Branch et al. 2007). Similarly, there have only been only two sighting records off southwestern Africa and no strandings since 1973, even though large catches occurred there (Branch et al. 2007). It is possible that this population was almost extirpated by whaling (Branch et al. 2007).

For the South Atlantic, there are two records in the OBIS database of blue whale sightings in offshore waters and two records off the coast of Argentina (OBIS 2015). One offshore sighting was made at 13.4°S, 26.8°W and the other at 15.9°S, 4.6°W (Maughan 2003; Branch et al. 2007). The occurrence of blue whales in the Tristan da Cunha archipelago also seems likely (Bester and Ryan 2007). At least one sighting has been made to the southeast of the region (Branch et al. 2007).

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

The sperm whale is widely distributed, occurring from the edge of the polar pack ice to the Equator in both hemispheres (Whitehead 2009). In general, it is distributed over large temperate and tropical areas that have high secondary productivity and steep underwater topography, such as volcanic islands

(Jaquet and Whitehead 1996). Its distribution and relative abundance can vary in response to prey availability, most notably squid (Jaquet and Gendron 2002).

The closest sperm whale sighting to the proposed survey area was at 30.1°S, 14.3°E (Clingham et al. 2013). Bester and Ryan (2007) reported that sperm whales might be common in the Tristan da Cunha archipelago. Catches of sperm whales in the 19th century were made in Tristan waters between October and January (Townsend 1935 *in* Best et al. 2009), and catches also occurred there in the 1960s (Best et al. 2009). One group was seen at St. Helena during July 2009 (Clingham et al. 2013). Whaling data from the South Atlantic indicate that sperm whales may be migratory off South Africa, with peak abundances reported in the region during autumn and late winter/spring (Best 2007).

There are ~3080 records of sperm whales for the South Atlantic in the OBIS database, including nearshore waters of South American and Africa and offshore waters (OBIS 2015). Most (3069) records are from historical catch data; ~11 catches occurred near the proposed survey area, between 30–32°S and 12–28°W (Townsend 1931, 1935 *in* OBIS 2015).

Dwarf (*Kogia sima*) and Pygmy (*K. breviceps*) Sperm Whales

Dwarf and pygmy sperm whales are distributed widely throughout tropical and temperate seas, but their precise distributions are unknown because much of what we know of the species comes from strandings (McAlpine 2009). They are difficult to sight at sea, because of their dive behavior and perhaps because of their avoidance reactions to ships and behavior changes in relation to survey aircraft (Würsig et al. 1998). The two species are often difficult to distinguish from one another when sighted (McAlpine 2009).

Both *Kogia* species are sighted primarily along the continental shelf edge and slope and over deeper waters off the shelf (Hansen et al. 1994; Davis et al. 1998; Jefferson et al. 2008). Several studies have suggested that pygmy sperm whales live mostly beyond the continental shelf edge, whereas dwarf sperm whales tend to occur closer to shore, often over the continental shelf (Rice 1998; Wang et al. 2002; MacLeod et al. 2004). Barros et al. (1998), on the other hand, suggested that dwarf sperm whales could be more pelagic and dive deeper than pygmy sperm whales. It has also been suggested that the pygmy sperm whale is more temperate and the dwarf sperm whale more tropical, based at least partially on live sightings at sea from a large database from the eastern tropical Pacific (Wade and Gerrodette 1993). This idea is also supported by the distribution of strandings in South American waters (Muñoz-Hincapié et al. 1998).

Kogia sp. were sighted during surveys off St. Helena during August–October 2004 (Clingham et al. 2013). There are no records of *Kogia* sp. in the offshore waters of the proposed survey area (OBIS 2015). The only records in the OBIS database for the South Atlantic are for Africa; more than 50 records of *K. breviceps* and 22 records of *K. sima* exist for southwestern Africa (OBIS 2015). In addition, both species have been reported for southwestern Brazil (de Oliveira Santos et al. 2010).

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale is probably the most widespread and common of the beaked whales, although it is not found in high-latitude polar waters (Heyning 1989). It is rarely observed at sea and is known mostly from strandings; it strands more commonly than any other beaked whale (Heyning 1989). Cuvier's beaked whale is found in deep water over and near the continental slope (Gannier and Epinat 2008; Jefferson et al. 2008).

In the South Atlantic, there are stranding records for Brazil, Uruguay, Argentina, the Falkland Islands, and South Africa (MacLeod et al. 2006). Records for Brazil include one stranding at Trindade Island (Fisch and Port 2013). Sighting records exist for nearshore Brazil, South Africa, the central South

Atlantic, the Southern Ocean (Findlay et al. 1992; MacLeod et al. 2006), Gabon (Weir 2007a), and Angola (Best 2007). Bester and Ryan (2007) suggested that Cuvier's beaked whales likely occur in the Tristan da Cunha archipelago. There are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015).

Arnoux's Beaked Whale (*Berardius arnuxii*)

Arnoux's beaked whale is distributed in deep, cold, temperate and subpolar waters of the Southern Hemisphere, with most records for southeastern South America, the Falkland Islands, the Antarctic Peninsula, South Africa, New Zealand, and southern Australia (MacLeod et al. 2006; Jefferson et al. 2008). It typically occurs south of 40°S (Jefferson et al. 2008), but has been reported as far north as 24°S (Kasuya 2009). Arnoux's beaked whales likely occur in the Tristan da Cunha archipelago (Bester and Ryan 2007). There are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015).

Shepherd's Beaked Whale (*Tasmacetus shepherdi*)

Based on known records, it is likely that Shepherd's beaked whale has a circumpolar distribution in the cold temperate waters of the Southern Hemisphere (Mead 1989a). It is primarily known from strandings, most of which have been recorded in New Zealand (Pitman et al. 2006; Mead 2009). The Tristan da Cunha archipelago has the second highest number of strandings (Mead 2009) and is thought to be a concentration area for Shepherd's beaked whales (Bester and Ryan 2007; Best et al. 2009). Pitman et al. (2006) and Best et al. (2009) reported six stranding records for Tristan da Cunha and possible sightings on the Tristan Plateau (2 sightings of 10 whales on 17 November 1985 near 37.3°S, 12.5°W) and Gough Island (one sighting of 4–5 animals). Another stranding of two whales on Tristan da Cunha occurred on 13 January 2012 (Best et al. 2014).

Additional records in the South Atlantic include a sighting in the Scotia Sea and several strandings in Argentina (Grandi et al. 2005; MacLeod et al. 2006; Pitman et al. 2006; Best et al. 2009; Mead 2009). Based on the known distributional range of Shepherd's beaked whale (MacLeod et al. 2006; Jefferson et al. 2008), the proposed survey area is at the northernmost extent of its range. There are no records for pelagic waters of the South Atlantic in the OBIS database (OBIS 2015).

Southern Bottlenose Whale (*Hyperoodon planifrons*)

The southern bottlenose whale is found throughout the Southern Hemisphere from 30°S to the ice edge, with most sightings reported between ~57°S and 70°S (Jefferson et al. 2008). It is apparently migratory, occurring in Antarctic waters during summer (Jefferson et al. 2008). Several sighting and stranding records exist for southeastern South America, the Falkland Islands, South Georgia Island, and South Africa, and numerous sightings have been reported for the Southern Ocean (Findlay et al. 1992; MacLeod et al. 2006). The Falkland Islands/Tierra del Fuego area is considered a beaked whale key area (MacLeod and Mitchell 2006). Southern bottlenose whales were regularly seen there during September–February 1998–2001 (White et al. 2002).

Southern bottlenose whales likely occur in the Tristan da Cunha archipelago (Bester and Ryan 2007). The proposed survey area is at the northernmost extent of the southern bottlenose whale's distribution range (Best 2007; Jefferson et al. 2008). There is one record in the OBIS database of a sighting in the central South Atlantic, which was made by the U.K. Royal Navy on 14 December 1999 at 37.1°S, 12.3°W (Maughan 2003).

Hector's Beaked Whale (*Mesoplodon hectori*)

Hector's beaked whale is thought to have a circumpolar distribution in temperate waters of the Southern Hemisphere (Pitman 2009). Based on the number of stranding records for the species, it appears to be relatively rare. Nonetheless, in the South Atlantic, strandings have been reported for southern Brazil, Argentina, the Falkland Islands, and South Africa (MacLeod et al. 2006). There are no OBIS records for this species for the South Atlantic (OBIS 2015).

True's Beaked Whale (*Mesoplodon mirus*)

True's beaked whale has a disjunct, antitropical distribution (Jefferson et al. 2008). In the Southern Hemisphere, it is known to occur in South Africa, South America, and Australia (Findlay et al. 1992; MacLeod and Mitchell 2006; MacLeod et al. 2006). These areas may comprise three separate populations; the region of South Africa in the Indian Ocean is considered a key beaked whale area (MacLeod and Mitchell 2006). In the South Atlantic, True's beaked whale has stranded on Tristan da Cunha (Best et al. 2009). Records also exist for South Africa and Brazil (de Souza et al. 2005; MacLeod et al. 2006; Best et al. 2009). Based on stranding and sighting data, the proposed survey area is part of the possible range of True's beaked whale (MacLeod et al. 2006; Best 2007; Jefferson et al. 2008). There are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015).

Gervais' Beaked Whale (*Mesoplodon europaeus*)

Although Gervais' beaked whale is generally considered to be a North Atlantic species, it likely occurs in deep waters of the temperate and tropical Atlantic Ocean in both the Northern and Southern hemispheres (Jefferson et al. 2008). Stranding records have been reported for Brazil and Ascension Island in the central South Atlantic (MacLeod et al. 2006). The southernmost stranding record was reported for São Paulo, Brazil, possibly expanding the known distributional range of this species southward (de Oliveira Santos et al. 2003). Although the distribution range of Gervais' beaked whale is not known to extend as far south as the proposed survey area, this species might range as far south as Uruguay and Angola in the South Atlantic (MacLeod et al. 2006; Jefferson et al. 2008). There are no OBIS records for the South Atlantic (OBIS 2015).

Gray's Beaked Whale (*Mesoplodon grayi*)

Gray's beaked whale is thought to have a circumpolar distribution in temperate waters of the Southern Hemisphere (Pitman 2009). It primarily occurs in deep waters beyond the edge of the continental shelf (Jefferson et al. 2008). Some sightings have been made in very shallow water, usually of sick animals coming in to strand (Gales et al. 2002; Dalebout et al. 2004).

In the South Atlantic, several stranding records exist for the southeast coast of South America, the Falkland Islands, and South Africa (Findlay et al. 1992; MacLeod et al. 2006; Otley 2012; Otley et al. 2012). Additionally, one sighting was reported off the southwestern tip of South Africa (MacLeod et al. 2006). There are numerous sighting records from Antarctic and sub-Antarctic waters (MacLeod et al. 2006); in summer months, Gray's beaked whales appear near the Antarctic Peninsula and along the shores of the continent (sometimes in the sea ice). Gray's beaked whales likely occur in the Tristan da Cunha archipelago (Bester and Ryan 2007). There are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015).

Andrew's Beaked Whale (*Mesoplodon bowdoini*)

Andrew's beaked whale has a circumpolar distribution in temperate waters of the Southern Hemisphere (Baker 2001; Pitman 2009). It is known only from stranding records between 32°S and

55°S, with more than half of the strandings occurring in New Zealand (Jefferson et al. 2008). In the South Atlantic, Andrew's beaked whales have also stranded in the Tristan da Cunha archipelago, the Falkland Islands, and Uruguay (Baker 2001; Laporta et al. 2005; MacLeod et al. 2006; Best et al. 2009). Based on its known distribution range (MacLeod et al. 2006; Jefferson et al. 2008), the proposed survey area is at the northernmost extent of its range in the South Atlantic. There are no OBIS records for the South Atlantic (OBIS 2015).

Strap-toothed Beaked Whale (*Mesoplodon layardii*)

The strap-toothed beaked whale is thought to have a circumpolar distribution in temperate and sub-antarctic waters of the Southern Hemisphere, mostly between 32° and 63°S (MacLeod et al. 2006; Jefferson et al. 2008). It might undertake limited migration to warmer waters during the austral winter (Pitman 2009). Strap-toothed whales are thought to migrate northward from Antarctic and sub-Antarctic latitudes during April–September (Sekiguchi et al. 1995).

In the South Atlantic, stranding records have been reported for Brazil, Uruguay, Argentina, the Falkland Islands, South Georgia, and South Africa (Findlay et al. 1992; Pinedo et al. 2002a; MacLeod et al. 2006; Otley et al. 2012). In addition, sightings have been reported off the southern tip of Africa, near Bouvet Island, and in the Southern Ocean (MacLeod et al. 2006). Bester and Ryan (2007) suggested that strap-toothed beaked whales likely occur in the Tristan da Cunha archipelago (Bester and Ryan 2007). There are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015).

Blainville's Beaked Whale (*Mesoplodon densirostris*)

Blainville's beaked whale is found in tropical and warm temperate waters of all oceans (Jefferson et al. 2008; Pitman 2009). It has the widest distribution throughout the world of all *Mesoplodon* species (Mead 1989b; Pitman 2009). In the South Atlantic, strandings have been reported for southern Brazil and South Africa (Findlay et al. 1992; MacLeod et al. 2006). A sighting was made during a boat survey off St. Helena in November 2007 (Clingham et al. 2013). There are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015).

Spade-toothed Beaked Whale (*Mesoplodon traversii*)

The spade-toothed beaked whale is the name proposed for the species formerly known as Bahamonde's beaked whale (*M. bahamondi*); genetic evidence has shown that it belongs to the species first identified by Gray in 1874 (van Helden et al. 2002). The spade-toothed beaked whale is considered relatively rare and is known from only four records, three from New Zealand and one from Chile (Thompson et al. 2012). Although no records currently exist for the South Atlantic, the known records at similar latitudes suggest that the spade-toothed beaked whale could occur in the proposed survey area.

Rough-toothed Dolphin (*Steno bredanensis*)

The rough-toothed dolphin is distributed worldwide in tropical, subtropical, and warm temperate waters (Miyazaki and Perrin 1994). It is generally seen in deep, oceanic water, although it is known to occur in coastal waters of Brazil (Flores and Ximinez 1997). One rough-toothed dolphin sighting was made during an August–September 2010 survey off Brazil from Vitória at ~20°S, 40°W to Trindade and Martim Vaz islands; the group of 30 individuals was seen in association with two minke whales at ~19.1°S, 35.1°W on 21 August (Wedekin et al. 2014). Rough-toothed dolphins have also been sighted at St. Helena (MacLeod and Bennett 2007; Clingham et al. 2013) and at 32.5°S, 2.0°W (Peters 1876 *in* Best et al. 2009).

For the South Atlantic, there are 42 records of rough-toothed dolphin in the OBIS database, including two offshore records to the far north of the proposed survey area, one record for Brazil, one for South Africa, and one for Gabon (OBIS 2015). Rough-toothed dolphins have also been sighted off Gabon (de Boer 2010) and Angola (Weir 2007a, 2010).

Common Bottlenose Dolphin (*Tursiops truncatus*)

The bottlenose dolphin occurs in tropical, subtropical, and temperate waters throughout the world (Wells and Scott 2009). In the South Atlantic, it occurs as far south as South Africa and Tierra del Fuego (Wells and Scott 2009; Goodall et al. 2011), and strandings have been reported for the Falkland Islands (Otley 2012). In many parts of the world, coastal and offshore ecotypes have been distinguished based on morphological, ecological, and physiological features (Jefferson et al. 2008).

Three sightings of common bottlenose dolphins were made at Trindade Island during December 2009–February 2010 surveys; two sightings of 15 individuals were made during December and a single bottlenose dolphin was sighted on 23 February (Souza de Carvalho and Rossi-Santos 2011). Additionally, two sightings of common bottlenose dolphins were made during an August–September 2010 survey from Vitória at ~20°S, 40°W to Trindade and Martim Vaz islands; both groups were seen on 30 August at Trindade Island, near 20.5°S, 29.3°W (Wedekin et al. 2014). Common bottlenose dolphins have also been sighted near St. Helena (MacLeod and Bennett 2007; Clingham et al. 2013).

Based on the distribution map in Jefferson et al. (2008), the waters of the proposed survey area are part of the secondary range of the common bottlenose dolphin. Although there are no records of common bottlenose dolphins in the offshore waters of the proposed survey area, in nearshore waters there are 3 records for Brazil, 98 for Argentina, and 27 for southwestern Africa (OBIS 2015). Common bottlenose dolphins have also been sighted off Gabon (de Boer 2010) and Angola (Weir 2007a, 2010).

Pantropical Spotted Dolphin (*Stenella attenuata*)

The pantropical spotted dolphin is distributed worldwide in tropical and some subtropical waters (Perrin 2009a), between ~40°N and 40°S (Jefferson et al. 2008). It is one of the most abundant cetaceans and is found in coastal, shelf, slope, and deep waters (Perrin 2009a). Based on the distribution maps in Jefferson et al. (2008) and Best (2007), the proposed survey area is within the distributional range of the pantropical spotted dolphin; however, based on maps provided by Moreno et al. (2005), the western survey area might not overlap its distributional range. For the South Atlantic, there is one record for Brazil and one record for South Africa (OBIS 2015). Pantropical spotted dolphins have been sighted off Brazil (Moreno et al. 2005), Gabon (de Boer 2010), Angola (Weir 2007a, 2010), and St. Helena (MacLeod and Bennett 2007; Clingham et al. 2013).

Spinner Dolphin (*Stenella longirostris*)

The spinner dolphin is pantropical in distribution, with a range nearly identical to that of the pantropical spotted dolphin, including oceanic tropical and sub-tropical waters between 40ºN and 40ºS (Jefferson et al. 2008). It is generally considered a pelagic species (Perrin 2009b), but can also be found in coastal waters and around oceanic islands (Rice 1998). Spinner dolphins are extremely gregarious, and usually form large schools in the open sea and small ones in coastal waters (Perrin and Gilpatrick 1994).

Although its distributional range appears to be to the north of the proposed survey area in the South Atlantic (Best 2007; Jefferson et al. 2008), it is possible that spinner dolphins occur at the western end of the proposed transect line (see Moreno et al. 2005). There are two OBIS records for the South Atlantic: one sighting north of the Falkland Islands at 47.4°S, 54.2°W made by the U.K. Royal Navy in November

2011 (Maughan 2003) and another off Brazil at 23.1°S, 43.1°W during April 1988 (OBIS 2015). Other sightings off Brazil have also been reported by Moreno et al. (2005).

Clymene Dolphin (*Stenella clymene*)

The Clymene dolphin only occurs in tropical and subtropical waters of the Atlantic Ocean (Jefferson et al. 2008). It inhabits areas where water depths are 700–4500 m or deeper (Fertl et al. 2003). In the western Atlantic, it occurs from New Jersey to Florida, the Caribbean Sea, the Gulf of Mexico, and south to Venezuela and Brazil (Würsig et al. 2000; Fertl et al. 2003).

Although currently available information indicates that the proposed survey area might not overlap with the distributional range of the Clymene dolphin (e.g., Fertl et al. 2003; Best 2007; Jefferson et al. 2008), it is possible that some individuals could be encountered at the western end of the survey transect (see Moreno et al. 2005). There are no OBIS records for the South Atlantic (OBIS 2015).

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin has a cosmopolitan distribution in tropical to warm temperate waters from ~50°N to 40°S (Perrin et al. 1994; Jefferson et al. 2008). It occurs primarily in pelagic waters, but has been observed approaching shore where there is deep water close to the coast (Jefferson et al. 2008). In the South Atlantic, it is known to occur along the coast of South America, from Brazil to Argentina, and along the west coast of Africa (Jefferson et al. 2008).

The proposed survey area might possibly overlap the distributional range of the striped dolphin (see Moreno et al. 2005; Best 2007; Jefferson et al. 2008). There are 58 OBIS records for the South Atlantic, including nearshore waters of Brazil, Uruguay, Argentina, Angola, and South Africa (OBIS 2015), and 19 records for offshore waters near 8.4°S, 24.4°W made during tuna fisheries research (Cauquil et al. 2012).

Fraser's Dolphin (*Lagenodelphis hosei*)

Fraser's dolphin is a tropical oceanic species distributed between 30°N and 30°S that generally inhabits deeper, offshore water (Dolar 2009). Strandings in more temperate waters, such as in Uruguay, are likely extralimital (Dolar 2009). For the South Atlantic, there are no OBIS records for the offshore waters of the proposed survey area (OBIS 2015), but there are 24 records for the coast of South America (Reyes 2006). Fraser's dolphin has also been sighted in the Gulf of Guinea and off Angola (Weir et al. 2008; Weir 2010).

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin is found in tropical and warm temperate oceans around the world (Jefferson et al. 2008). It is the most abundant dolphin species in offshore areas of warm-temperate regions in the North Atlantic and Pacific (Perrin 2009c). It can be found in oceanic or coastal habitats; it is common in coastal waters 200–300 m deep and is also associated with prominent underwater topography, such as seamounts (Evans 1994). Although Jefferson et al. (2008) and Perrin (2009c) reported that its occurrence in the South Atlantic is uncertain, Best (2007) reported numerous records for the waters off southern Africa. Offshore records to the southwest of the proposed survey area have been made near 40°S, 13°W, and 37°S, 9°W (Best 2007). The short-beaked common dolphin has also been reported for the waters to the east of South Africa (Samaii et al. 2007). For the South Atlantic, there are 4 OBIS records for South America and nearly 80 records for southwestern Africa (OBIS 2015).

Hourglass Dolphin (*Lagenorhynchus cruciger*)

The hourglass dolphin occurs in all parts of the Southern Ocean south of ~45°S, with most sightings between 45°S and 60°S (Goodall 2009). However, some sightings have been made as far north as 33°S, so the possible range for this species might extend northward to the proposed survey area (Jefferson et al. 2008). Although it is pelagic, it is also sighted near banks and islands (Goodall 2009). Bester and Ryan (2007) reported that the hourglass dolphin might occur south of Gough Island. There are 8 records for the western South Atlantic in the OBIS database, including records for Argentina, the Falkland Islands, and South Georgia (OBIS 2015).

Southern Right Whale Dolphin (*Lissodelphis peronii*)

The southern right whale dolphin is distributed between the Subtropical and Antarctic convergences in the Southern Hemisphere, generally between ~30ºS and 65ºS (Jefferson et al. 2008). It is sighted most often in cool, offshore waters, although it is sometimes seen near shore where coastal waters are deep (Jefferson et al. 2008), such as off Namibia (Rose and Payne 1991; Findlay et al. 1992). Cold-water currents, such as the Malvinas current off Brazil, might also influence its distribution, extending its range northward (Lipsky 2009). Bester and Ryan (2007) suggested that southern right whale dolphins might be visitors to the southern waters of the Tristan da Cunha archipelago. One was captured near Tristan da Cunha on 10 December 1847 at 37.1°S, 11.6°W (Cruickshank and Brown 1981 *in* Best et al. 2009). There are no records for the South Atlantic in the OBIS database (OBIS 2015).

Melon-headed Whale (*Peponocephala electra*)

The melon-headed whale is an oceanic species found worldwide in tropical and subtropical waters from ~40°N to 35°S (Jefferson et al. 2008). It occurs most often in deep offshore waters and occasionally in nearshore areas where deep oceanic waters occur near the coast (Perryman 2009). Off the west coast of Africa, melon-headed whales have been recorded off Gabon (de Boer 2010) and Angola (Weir 2007a, 2010), and an extralimital record exists for South Africa (Jefferson et al. 2008). Based on the distribution map in Jefferson et al. (2008), the proposed survey area is at the southernmost extent of the melon-headed whale's range. There is a single record for the South Atlantic off South Africa, held by the Iziko South African museum (OBIS 2015); this record is considered to be extralimital (Jefferson et al. 2008).

Pygmy Killer Whale (*Feresa attenuata*)

The pygmy killer whale has a worldwide distribution in tropical and subtropical waters (Donahue and Perryman 2009), generally not ranging south of 35°S (Jefferson et al. 2008). It is known to inhabit the warm waters of the Indian, Pacific, and Atlantic oceans (Jefferson et al. 2008). It can be found in nearshore areas where the water is deep and in offshore waters (Jefferson et al. 2008).

Based on the distribution map in Jefferson et al. (2008), the proposed survey area is at the southernmost extent of the pygmy killer whale's range. There are no records for the offshore waters of the proposed survey area, but there are 5 records at the Iziko South African Museum for the southwestern coast of Africa (OBIS 2015). In addition, there is one stranding record for Brazil (de Oliveira Santos et al. 2010).

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters, generally between 50ºN and 50ºS (Odell and McClune 1999). It is widely distributed, but not abundant anywhere (Carwardine 1995). The false killer whale generally inhabits deep, offshore waters, but sometimes is found over the continental shelf and occasionally moves into very shallow water (Jefferson et al. 2008; Baird 2009). It is gregarious and forms strong social bonds, as is evident from its propensity to strand en masse (Baird 2009).

Based on the distribution map in Jefferson et al. (2008), the primary range of the false killer whale in the South Atlantic extends along the coast of South America and Africa, and the open waters of the South Atlantic are considered part of its secondary range, extending south to ~29°S. False killer whales are known to prey on the Uruguayan pelagic longline fishery (Passadore et al. 2015). They have also been recorded around St. Helena (Clingham et al. 2013). Although there are no OBIS records of false killer whales for the offshore waters of the proposed survey area, there are 91 records for the South Atlantic, including offshore waters off South America and nearshore waters off southwestern Africa (OBIS 2015).

Killer Whale (*Orcinus orca*)

The killer whale is cosmopolitan and globally abundant; it has been observed in all oceans of the world (Ford 2009). It is very common in temperate waters but also occurs in tropical waters (Heyning and Dahlheim 1988), and it inhabits coastal as well as offshore regions (Budylenko 1981).

Based on sightings by whaling vessels between 1960 and 1979, killer whales are distributed throughout the South Atlantic (Budylenko 1981; Mikhalev et al. 1981). Mikhalev et al. (1981) noted that they appear to migrate from warmer waters during the winter to higher latitudes during the summer. Sightings of killer whale pods of 1 to >100 individuals were made near the proposed survey area during November–April, with most sightings during November and December (Budylenko 1981; Mikhalev et al. 1981). Densities along 31°S likely are relatively low (Forney and Wade 2006).

Pinedo et al. (2002b) noted that killer whales are relatively common off southern Brazil, and they are also known to occur off Gabon (de Boer 2010), Angola (Weir 2007a; Weir et al. 2010), as well as Namibia, and South Africa (Findlay et al. 1992). Killer whales are known to prey on longline catches in the waters off southern Brazil (Dalla Rosa and Secchi 2007) and South Africa (Williams et al. 2009). They are also known to prey on the Uruguayan pelagic longline fishery (Passadore et al. 2015). One predation event by a killer whale was recorded for waters just to the north of the proposed survey area, at ~29°S, 28°S, with several other predation events and sightings to the northwest (Passadore et al. 2014, 2015). Killer whales occur in the Uruguayan fishing grounds throughout the year, but most frequently during autumn and winter and ~300–750 km from shore along the shelf break (Passadore et al. 2014).

Killer whales are considered scarce in the Tristan da Cunha archipelago (Bester and Ryan 2007), but they have been sighted there during September and October (Best et al. 2009). They have also been recorded for waters near St. Helena (Clingham et al. 2013). One killer whale sighting was made during an August–September 2010 survey from Vitória at ~20°S, 40°W to Trindade and Martim Vaz islands; the pod was seen to the east of Vitória, near 20.5°S, 37.2°W, on 4 September (Wedekin et al. 2014). There are ~40 records of killer whales for the South Atlantic in the OBIS database, including records for offshore and nearshore waters of South America (OBIS 2015). The record closest to the proposed survey area was made by the U.K. Royal Navy on 26 November 1996 at 37.0°S, 12.3°W, ~1600 km south of the proposed survey area (Maughan 2003).

Short-finned (*Globicephala macrorhynchus*) and Long-finned (*G. melas*) Pilot Whales

The short-finned pilot whale is found in tropical and warm temperate waters, and the long-finned pilot whale is distributed antitropically in cold temperate waters (Olson 2009). The ranges of the two species show little overlap (Olson 2009). Short-finned pilot whale distribution does not generally range south of 40°S (Jefferson et al. 2008).

Long-finned pilot whales are considered uncommon in Tristan waters (Bester and Ryan 2007); pilot whales have stranded on the islands of the Tristan da Cunha archipelago, although it is uncertain what species they were (Best et al. 2009). There are no records of pilot whales in the offshore waters of the proposed survey area in the OBIS database, but there are >90 short-finned pilot whale records for the waters off South America and Africa and a single record of long-finned pilot whales off Brazil (OBIS 2015). In addition, there are records of long-finned pilot whales for South Africa (Findlay et al. 1992) and a stranding record at Tierra del Fuego, Argentina (Clarke and Goodall 1994).

Pinnipeds

Subantarctic Fur Seal (*Arctocephalus tropicalis*)

The subantarctic fur seal is distributed throughout the Southern Hemisphere (Jefferson et al. 2008). It breeds on subantarctic and subtemperate islands north of the Antarctic Polar Front (Arnould 2009). In the South Atlantic, the subantarctic fur seal breeds at the Tristan da Cunha archipelago (Bester and Ryan 2007). The largest breeding population is found on Gough Island (Bester et al. 2006). Arnould (2009) reported that the population on Gough Island numbers more than 200,000 seals. Bester and Ryan (2007) reported that ~80% of the world population (~300,000 seals) is found on Gough Island. The world population is estimated at >310,000 individuals (Arnould 2009). A few pups are also born at Tristan da Cunha Island, and the subantarctic fur seal can also be found on Nightingale and Inaccessible islands (Hofmeyr et al. 1997). Breeding/pupping at Tristan da Cunha archipelago occurs during late spring/early summer (Bester and Ryan 2007).

Vagrant subantarctic fur seals have been reported in South Africa (Shaughnessy and Ross 1980) and along the coast of Brazil (Ferreira et al. 2008; Oliveira et al. 2011). Most of the seals found in Brazil are from Gough Island, although others seem to come from breeding colonies much farther away, such as the Crozet Islands in the Indian Ocean (Ferreira et al. 2008). The at-sea distribution of subantarctic fur seals is poorly understood, although they are often seen in the waters between Tristan da Cunha and South Africa (Bester and Ryan 2007). Based on the distribution map in Jefferson et al. (2008), the pelagic waters of the proposed survey area are within the possible range of the subantarctic fur seal. There are no OBIS records for the offshore waters of the proposed survey area, but there are 13 OBIS records for South Africa, 21 records for pelagic waters near 40.3°S, 9.9°W, and one record for coastal waters of southern Brazil (OBIS 2015).

Southern Elephant Seal (*Mirounga leonina*)

The southern elephant seal has a near circumpolar distribution in the Southern Hemisphere (Jefferson et al. 2008), with breeding sites located on islands throughout the subantarctic (Hindell and Perrin 2009). In the South Atlantic, southern elephant seals breed at Patagonia, South Georgia, and other islands of the Scotia Arc, the Falklands, Bouvet Island, and Tristan da Cunha archipelago (Bester and Ryan 2007). Numbers on Tristan da Cunha have been low since southern elephant seals were hunted there (Bester and Ryan 2007). At Gough Island, the breeding season takes place during the austral spring; pups are born in October and start to disperse in December (Bester and Ryan 2007). Between 1973 and 1998, the number of births at Gough Island declined from 38 pups in 1975 to 11 in 1997 (Bester et al. 2001). Immature animals also haul out on Tristan da Cunha and Inaccessible islands (Bester and Ryan 2007).

When not breeding (September–October) or molting (November–April), southern elephant seals range throughout the Southern Ocean from areas north of the Antarctic Polar Front to the pack ice of the Antarctic (Hindell and Perrin 2009). Southern elephant seals tagged at South Georgia showed long-range movements from ~April through October into the open Southern Ocean and to the shelf of the Antarctic

Peninsula (McConnell and Fedak 1996); none were tracked as far north as the proposed survey area. One adult male that was sighted on Gough Island had previously been tagged at Marion Island in the Indian Ocean (Reisinger and Bester 2010). Vagrant southern elephant seals, mainly consisting of juvenile and subadult males, have been documented in Uruguay and Brazil (Lewis et al. 2006a; Oliveira et al. 2011).

Based on the distribution map in Jefferson et al. (2008), the proposed survey area is at the northernmost extent of the secondary range of the southern elephant seal. For the South Atlantic, there are more than 2000 OBIS records for the nearshore and offshore waters of South America and along the southwestern coast of Africa (OBIS 2015); most of the records (1793) are for waters of the Patagonian Large Marine Ecosystem (Campagna et al. 2006). The closest records (three) to the proposed survey area were made at 29.3°S, 33.8°W (Lewis et al. 2006b), ~500 km northwest of the proposed survey area.

V. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

L-DEO requests an IHA pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take by harassment during its planned seismic survey in the South Atlantic Ocean during austral summer 2016.

The operations outlined in § I have the potential to take marine mammals by harassment. Sounds would be generated by the airguns used during the survey, by echosounders, and by general vessel operations. "Takes" by harassment would potentially result when marine mammals near the activity are exposed to the pulsed sounds generated by the airguns or echosounders. The effects would depend on the species of marine mammal, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § VII). Disturbance reactions are likely amongst some of the marine mammals near the tracklines of the source vessel. No take by serious injury is expected, given the nature of the planned operations and the mitigation measures that are planned (see § XI, MITIGATION MEASURES). No lethal takes are expected.

VI. NUMBERS OF MARINE MAMMALS THAT COULD BE TAKEN

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section V], and the number of times such takings by each type of taking are likely to occur.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

VII. ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammal.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

- First we summarize the potential impacts on marine mammals of airgun operations, as called for in § VII. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS.

- Then we summarize the potential impacts of operations by the echosounders. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS.
- Finally, we estimate the numbers of marine mammals that could be affected by the proposed survey in the South Atlantic Ocean. This section includes a description of the rationale for the estimates of the potential numbers of harassment "takes" during the planned survey, as called for in § VI. Acoustic modeling was conducted by L-DEO, determined to be acceptable by NMFS to use in the calculation of estimated takes under the MMPA (e.g., NMFS 2013a,b).

Summary of Potential Effects of Airgun Sounds

As noted in the PEIS (§ 3.6.4.3, § 3.7.4.3, and § 3.8.4.3), the effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). In some cases, a behavioral response to a sound may in turn reduce the overall exposure to that sound (e.g., Finneran et al. 2015; Wensveen et al. 2015).

Permanent hearing impairment (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not considered an injury (Southall et al. 2007; Le Prell 2012). Rather, the onset of TTS has been considered an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility. Nonetheless, recent research has shown that sound exposure can cause cochlear neural degeneration, even when threshold shifts and hair cell damage are reversible (Liberman 2013). These findings have raised some doubts as to whether TTS should continue to be considered a non-injurious effect (Weilgart 2014; Tougaard et al. 2015). Although the possibility cannot be entirely excluded, it is unlikely that the proposed survey would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers (e.g., Nieukirk et al. 2012). Several studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (e.g., Gedamke 2011; Guerra et al. 2011, 2013; Klinck et al. 2012; Guan et al. 2015), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Thus, airgun sounds could have masking effects and reduce the communication range especially of large whales (Nieukirk et al. 2012; Blackwell et al. 2013; Wittekind et al. 2013).

Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses (e.g., Nieukirk et al. 2012; Broker et al. 2013). In addition, some cetaceans are known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behavior in response to airgun sounds (e.g., Di Iorio and Clark 2010; Castellote et al. 2012; Blackwell et al. 2013, 2015; Cerchio et al. 2014). The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly (e.g., MacGillivray et al. 2014). The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Based on NMFS (2001, p. 9293), NRC (2005), and Southall et al. (2007), we believe that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or “taking”. By potentially significant, we mean, ‘in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations’.

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007; Ellison et al. 2012). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population (New et al. 2013). However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (Lusseau and Bejder 2007; Weilgart 2007; Nowacek et al. 2015). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many marine mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of industrial sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species, there are no data on responses to marine seismic surveys.

Baleen Whales.—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995).

Responses of *humpback whales* to seismic surveys have been studied during migration, on summer feeding grounds, and on Angolan winter breeding grounds; there has also been discussion of effects on the Brazilian wintering grounds. Off Western Australia, avoidance reactions began at 5–8 km from the array, and those reactions kept most pods ~3–4 km from the operating seismic boat; there was localized displacement during migration of 4–5 km by traveling pods and 7–12 km by more sensitive resting pods of cow-calf pairs (McCauley et al. 1998, 2000). However, some individual humpback whales, especially males, approached within distances of 100–400 m. Studies examining the behavioral responses of humpback whales to airguns are currently underway off eastern Australia (Cato et al. 2011, 2012, 2013).

In the northwest Atlantic, sighting rates were significantly greater during non-seismic periods compared with periods when a full array was operating, and humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods (Moulton and Holst 2010). In contrast, sightings of humpback whales from seismic vessels off the U.K. from 1994 to 2010 indicated that detection rates were similar during seismic and non-seismic periods, although, sample sizes were small (Stone 2015). On their summer feeding grounds in southeast Alaska, there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis (Malme et al. 1985). It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel et al. 2004), but data from subsequent years, indicated that there was no observable direct correlation between strandings and seismic surveys (IWC 2007).

There are no data on reactions of *right whales* to seismic surveys. However, Rolland et al. (2012) suggested that ship noise causes increased stress in right whales; they showed that baseline levels of stress-related faecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater noise from vessels. Wright et al. (2011) and Atkinson et al. (2015) also reported that sound could be a potential source of stress for marine mammals.

Results from the closely related *bowhead whale* show that their responsiveness can be quite variable depending on their activity (migrating vs. feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). Subtle but statistically significant changes in surfacing–respiration–dive cycles were shown by traveling and socializing bowheads exposed to airgun sounds in the Beaufort Sea, including shorter surfacings, shorter dives, and decreased number of blows per surfacing (Robertson et al. 2013). More recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are less responsive to seismic sources (e.g., Miller et al. 2005; Robertson et al. 2013).

Bowhead whale calls detected in the presence and absence of airgun sounds have been studied extensively in the Beaufort Sea. Bowheads continue to produce calls of the usual types when exposed to airgun sounds on their summering grounds, although numbers of calls detected are significantly lower in the presence than in the absence of airgun pulses (Blackwell et al. 2013, 2015). Blackwell et al. (2013) reported that calling rates in 2007 declined significantly where received SPLs from airgun sounds were 116–129 dB re 1 µPa; at SPLs <108 dB re 1 µPa, calling rates were not affected. When data for 2007–2010 were analyzed, Blackwell et al. (2015) reported an initial increase in calling rates when airgun pulses became detectable; however, calling rates leveled off at a received $CSEL_{10\text{-min}}$ (cumulative SEL over a 10-min period) of ~94 dB re 1 $\mu Pa^2 \cdot s$, decreased at $CSEL_{10\text{-min}}$ >127 dB re 1 $\mu Pa^2 \cdot s$, and whales were nearly silent at $CSEL_{10\text{-min}}$ >160 dB re 1 $\mu Pa^2 \cdot s$. Thus, bowhead whales in the Beaufort Sea apparently decreased their calling rates in response to seismic operations, although movement out of the area could also have contributed to the lower call detection rate (Blackwell et al. 2013, 2015).

A multivariate analysis of factors affecting the distribution of calling bowhead whales during their fall migration in 2009 noted that the southern edge of the distribution of calling whales was significantly closer to shore with increasing levels of airgun sound from a seismic survey a few hundred kilometers to the east of the study area (i.e., behind the westward-migrating whales; McDonald et al. 2010, 2011). It was not known whether this statistical effect represented a stronger tendency for quieting of the whales farther offshore in deeper water upon exposure to airgun sound, or an actual inshore displacement of whales.

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{rms} (Malme et al. 1986, 1988). Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme et al. 1984; Malme and Miles 1985) and western Pacific gray whales feeding off Sakhalin Island, Russia (e.g., Gailey et al. 2007; Johnson et al. 2007; Yazvenko et al. 2007a,b).

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses. Sightings by observers on seismic vessels using large arrays off the U.K. from 1994 to 2010 showed that the detection rate for minke whales was significantly higher when airguns were not operating; however, during surveys with small arrays, the detection rates for minke whales were similar during seismic and non-seismic periods (Stone 2015). Sighting rates for fin and sei whales were similar when large arrays of airguns were operating vs. silent. All baleen whales combined tended to exhibit localized avoidance, remaining significantly farther (on average) from large arrays (median CPA ~1.5 km) during seismic operations compared with non-seismic periods (median CPA ~1.0 km). In addition, fin and minke whales were more often oriented away from the vessel while a large airgun array was active compared with periods of inactivity. Singing fin whales in the Mediterranean moved away from an operating airgun array, and their song notes had lower bandwidths during periods with vs. without airgun sounds (Castellote et al. 2012).

During seismic surveys in the northwest Atlantic, baleen whales as a group showed localized avoidance of the operating array (Moulton and Holst 2010). Sighting rates were significantly lower during seismic operations compared with non-seismic periods. Baleen whales were seen on average 200 m farther from the vessel during airgun activities vs. non-seismic periods, and these whales more often swam away from the vessel when seismic operations were underway compared with periods when no airguns were operating. Blue whales were seen significantly farther from the vessel during single airgun operations, ramp up, and all other airgun operations compared with non-seismic periods. Similarly, fin whales were seen at significantly farther distances during ramp up than during periods without airgun operations; there was also a trend for fin whales to be sighted farther from the vessel during other airgun operations, but the difference was not significant. Minke whales were seen significantly farther from the vessel during periods with than without seismic operations. Minke whales were also more likely to swim away and less likely to approach during seismic operations compared to periods when airguns were not operating (Moulton and Holst 2010).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year. Bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales.—Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Stone and Tasker 2006; Moulton and Holst 2010; Barry et al. 2012; Wole and Myade 2014; Stone 2015). In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance.

Observations from seismic vessels using large arrays off the U.K. from 1994 to 2010 indicated that detection rates were significantly higher for killer whales, white-beaked dolphins, and Atlantic white-sided dolphins when airguns were not operating; detection rates during seismic vs. non-seismic periods were similar during seismic surveys using small arrays (Stone 2015). Detection rates for long-finned pilot whales, Risso's dolphins, bottlenose dolphins, and short-beaked common dolphins were similar during seismic (small or large array) vs. non-seismic operations. CPA distances for killer whales, white-beaked dolphins, and Atlantic white-sided dolphins were significantly farther (>0.5 km) from large airgun arrays during periods of airgun activity compared with periods of inactivity, with significantly more animals traveling away from the vessel during airgun operation. Observers' records suggested that fewer cetaceans were feeding and fewer delphinids were interacting with the survey vessel (e.g., bow-riding) during periods with airguns operating.

During seismic surveys in the northwest Atlantic, delphinids as a group showed some localized avoidance of the operating array (Moulton and Holst 2010). The mean initial detection distance was significantly farther (by ~200 m) during seismic operations compared with periods when the seismic source was not active; however, there was no significant difference between sighting rates. The same results were evident when only long-finned pilot whales were considered.

Preliminary findings of a monitoring study of narwhals in Melville Bay, Greenland (summer and fall 2012) showed no short-term effects of seismic survey activity on narwhal distribution, abundance, migration timing, and feeding habits (Heide-Jørgensen et al. 2013a). In addition, there were no reported effects on narwhal hunting. These findings do not seemingly support a suggestion by Heide-Jørgensen et al. (2013b) that seismic surveys in Baffin Bay may have delayed the migration timing of narwhals, thereby increasing the risk of narwhals to ice entrapment.

The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels (e.g., Miller et al. 2005). Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviors (e.g., Finneran et al. 2000, 2002, 2005).

Most studies of sperm whales exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance (e.g., Stone and Tasker 2006; Moulton and Holst 2010), but foraging behavior can be altered upon exposure to airgun sound (e.g., Miller et al. 2009). Based on data collected by observers on seismic vessels off the

U.K. from 1994 to 2010, detection rates for sperm whales were similar when large arrays of airguns were operating vs. silent; however, during surveys with small arrays, the detection rate was significantly higher when the airguns were not in operation (Stone 2015). Preliminary data from the Gulf of Mexico show reduced sperm whale acoustic activity during periods with airgun operations (Sidorovskaia et al. 2014).

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (e.g., Würsig et al. 1998) and/or change their behavior in response to sounds from vessels (e.g., Pirotta et al. 2012). Thus, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel. Observations from seismic vessels off the U.K. from 1994 to 2010 indicated that detection rates of beaked whales were significantly higher (p<0.05) when airguns were not operating vs. when a large array was in operation, although sample sizes were small (Stone 2015). Some northern bottlenose whales remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (e.g., Simard et al. 2005).

The limited available data suggest that harbor porpoises show stronger avoidance of seismic operations than do Dall's porpoises. Based on data collected by observers on seismic vessels off the U.K. from 1994 to 2010, detection rates of harbor porpoises were significantly higher when airguns were silent vs. when large or small arrays were operating; in addition, harbor porpoises were seen farther away from the array when it was operating vs. silent, and were most often seen traveling away from the airgun array when it was in operation (Stone 2015). Thompson et al. (2013) reported decreased densities and reduced acoustic detections of harbor porpoise in response to a seismic survey in Moray Firth, Scotland, at ranges of 5–10 km (SPLs of 165–172 dB re 1 µPa, SELs of 145–151 dB µPa2 · s). For the same survey, Pirotta et al. (2014) reported that the probability of recording a porpoise buzz decreased by 15% in the ensonified area, and that the probability was positively related to the distance from the seismic ship; the decreased buzzing occurrence may indicate reduced foraging efficiency. Nonetheless, animals returned to the area within a few hours (Thompson et al. 2013). Kastelein et al. (2013a) reported that a harbor porpoise showed no response to an impulse sound with an SEL below 65 dB, but a 50% brief response rate was noted at an SEL of 92 dB and an SPL of 122 dB re 1 $\mu Pa_{0\text{-peak}}$. The apparent tendency for greater responsiveness in the harbor porpoise is consistent with its relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995; Southall et al. 2007).

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Pinnipeds.—Pinnipeds are not likely to show a strong avoidance reaction to an airgun array. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. However, telemetry work has suggested that avoidance and other behavioral reactions may be stronger than evident to date from visual studies (Thompson et al. 1998). Observations from seismic vessels operating large arrays off the U.K. from 1994 to 2010 showed that the detection rate for grey seals was significantly higher when airguns were not operating; for surveys using small arrays, the detection rates were similar during seismic vs. non-seismic operations (Stone 2015). No significant differences in detection rates were apparent for harbor seals during seismic and non-seismic periods. There were no significant differences in CPA distances of grey or harbour seals during seismic vs. non-seismic periods.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds (see review by Finneran 2015). However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.

Additional data are needed to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sound with variable received levels. To determine how close an airgun array would need to approach in order to elicit TTS, one would (as a minimum) need to allow for the sequence of distances at which airgun pulses would occur, and for the dependence of received SEL on distance in the region of the seismic operation (e.g., Breitzke and Bohlen 2010; Laws 2012). At the present state of knowledge, it is also necessary to assume that the effect is directly related to total received energy (SEL); however, this assumption is likely an over-simplification (Finneran 2012). There is recent evidence that auditory effects in a given animal are not a simple function of received acoustic energy (Finneran 2015). Frequency, duration of the exposure, and occurrence of gaps within the exposure can also influence the auditory effect (Finneran and Schlundt 2010, 2011, 2013; Finneran et al. 2010a,b; Popov et al. 2011, 2013a; Finneran 2012, 2015; Kastelein et al. 2012a,b; 2013b,c, 2014, 2015a; Ketten 2012).

Recent data have shown that the SEL required for TTS onset to occur increases with intermittent exposures, with some auditory recovery during silent periods between signals (Finneran et al. 2010b; Finneran and Schlundt 2011). Studies on bottlenose dolphins by Finneran et al. (2015) indicate that the potential for seismic surveys using airguns to cause auditory effects on dolphins could be lower than previously thought. Based on behavioral tests, Finneran et al. (2015) reported no measurable TTS in three bottlenose dolphins after exposure to 10 impulses from a seismic airgun with a cumulative SEL of up to ~195 dB re 1 $\mu Pa^2 \cdot s$. However, auditory evoked potential measurements were more variable; one dolphin showed a small (9 dB) threshold shift at 8 kHz (Finneran et al. 2015).

Recent studies have also shown that the SEL necessary to elicit TTS can depend substantially on frequency, with susceptibility to TTS increasing with increasing frequency above 3 kHz (Finneran and Schlundt 2010, 2011; Finneran 2012). When beluga whales were exposed to fatiguing noise with sound levels of 165 dB re 1 µPa for durations of 1–30 min at frequencies of 11.2–90 kHz, the highest TTS with the longest recovery time was produced by the lower frequencies (11.2 and 22.5 kHz); TTS effects also gradually increased with prolonged exposure time (Popov et al. 2013a). Additionally, Popov et al. (2015) demonstrated that the impacts of TTS include deterioration of signal discrimination. Kastelein et al. (2015b) reported that exposure to multiple pulses with most energy at low frequencies can lead to TTS at higher frequencies in some cetaceans, such as the harbor porpoise.

Popov et al. (2013b) reported that TTS produced by exposure to a fatiguing noise was larger during the first session (or naïve subject state) with a beluga whale than TTS that resulted from the same sound in subsequent sessions (experienced subject state). Similarly, several other studies have shown that some marine mammals (e.g., bottlenose dolphins, false killer whales) can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (e.g., Nachtigall and Supin 2013, 2014, 2015)

Previous information on TTS for odontocetes was primarily derived from studies on the bottlenose dolphin and beluga, and that for pinnipeds has mostly been obtained from California sea lions and elephant seals (see § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS). Thus, it is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans or pinnipeds (cf. Southall et al. 2007). Some cetaceans or pinnipeds could incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga and bottlenose dolphin or California sea lion and elephant seal, respectively.

Several studies on TTS in porpoises (e.g., Lucke et al. 2009; Popov et al. 2011; Kastelein et al. 2012a, 2013a,b, 2014, 2015a) indicate that received levels that elicit onset of TTS are lower in porpoises than in other odontocetes. Kastelein et al. (2012a) exposed a harbor porpoise to octave band noise centered at 4 kHz for extended periods of time. A 6-dB TTS occurred with SELs of 163 dB and 172 dB for low-intensity sound and medium-intensity sound, respectively; high-intensity sound caused a 9-dB TTS at a SEL of 175 dB (Kastelein et al. 2012a). Kastelein et al. (2013b) exposed a harbor porpoise to a long, continuous 1.5-kHz tone, which induced a 14-dB TTS with a total SEL of 190 dB. Popov et al. (2011) examined the effects of fatiguing noise on the hearing threshold of Yangtze finless porpoises when exposed to frequencies of 32–128 kHz at 140–160 dB re 1 µPa for 1–30 min. They found that an exposure of higher level and shorter duration produced a higher TTS than an exposure of equal SEL but of lower level and longer duration. Popov et al. (2011) reported a TTS of 25 dB for a Yangtze finless porpoise that was exposed to high levels of 3-min pulses of half-octave band noise centered at 45 kHz with an SEL of 163 dB.

Initial evidence from exposures to non-pulses has also suggested that some pinnipeds (harbor seals in particular) incur TTS at somewhat lower received levels than do most small odontocetes exposed for similar durations (Kastak et al. 1999, 2005, 2008; Ketten et al. 2001). Kastelein et al. (2012b) exposed two harbor seals to octave-band white noise centered at 4 kHz at three mean received SPLs of 124, 136, and 148 dB re 1 µPa; TTS >2.5 dB was induced at an SEL of 170 dB (136 dB SPL for 60 min), and the maximum TTS of 10 dB occurred after a 120-min exposure to 148 dB re 1 µPa or an SEL of 187 dB. Kastelein et al. (2013c) reported that a harbor seal unintentionally exposed to the same sound source with a mean received SPL of 163 dB re 1 µPa for 1 h induced a 44 dB TTS. For a harbor seal exposed to octave-band white noise centered at 4 kHz for 60 min with mean SPLs of 124–148 re 1 µPa, the onset of PTS would require a level of at least 22 dB above the TTS onset (Kastelein et al. 2013c).

Based on the best available information at the time, Southall et al. (2007) recommended a TTS threshold for exposure to single or multiple pulses of 183 dB re 1 $\mu Pa^2 \cdot s$ for all cetaceans and 173 dB re 1 $\mu Pa^2 \cdot s$ for pinnipeds in water. For the harbor porpoise, Tougaard et al. (2015) have suggested an exposure limit for TTS as an SEL of 100–110 dB above the pure tone hearing threshold at a specific frequency; they also suggested an exposure limit of Leq-fast (rms average over the duration of the pulse) of 45 dB above the hearing threshold for behavioral responses (i.e., negative phonotaxis). In addition, M-weighting, as used by Southall et al. (2007), might not be appropriate for the harbor porpoise (Wensveen et al. 2014; Tougaard et al. 2015); thus, Wensveen et al. (2014) developed six auditory weighting functions for the harbor porpoise that could be useful in predicting TTS onset. Gedamke et al. (2011), based on preliminary simulation modeling that attempted to allow for various uncertainties in assumptions and variability around population means, suggested that some baleen whales whose closest point of approach to a seismic vessel is 1 km or more could experience TTS.

Hermannsen et al. (2015) reported that there is little risk of hearing damage to harbor seals or harbor porpoises, which are thought to incur TTS at lower received levels than do most small odontocetes, when using single airguns in shallow water. Similarly, it is unlikely that a marine mammal would remain close enough to a large airgun array for sufficiently long to incur TTS, let alone PTS. There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that some mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995, p. 372ff; Gedamke et al.

2011). In terrestrial animals, exposure to sounds sufficiently strong to elicit a large TTS induces physiological and structural changes in the inner ear, and at some high level of sound exposure, these phenomena become non-recoverable (Le Prell 2012). At this level of sound exposure, TTS grades into PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS (e.g., Kastak and Reichmuth 2007; Kastak et al. 2008).

Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds with received levels ≥180 dB and 190 dB re 1 μPa_{rms}, respectively (NMFS 2000). These criteria have been used in establishing the exclusion (=shut-down) zones planned for the proposed seismic survey. However, those criteria were established before there was any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals.

Recommendations for science-based noise exposure criteria for marine mammals, frequency-weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations were never formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys, although some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. In July 2015, NOAA made available for a second public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2015), taking at least some of the Southall et al. recommendations into account. At the time of preparation of this document, the date of release of the final guidelines and how they would be implemented are unknown.

Nowacek et al. (2013) concluded that current scientific data indicate that seismic airguns have a low probability of directly harming marine life, except at close range. Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § XI and § XIII). Also, many marine mammals and (to a limited degree) sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds.

There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. However, Gray and Van Waerebeek (2011) have suggested a cause-effect relationship between a seismic survey off Liberia in 2009 and the erratic movement, postural instability, and akinesia in a pantropical spotted dolphin based on spatially and temporally close association with the airgun array. Additionally, a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings (e.g., Castellote and Llorens 2013).

Non-auditory effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects. The brief duration of exposure of any given mammal and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals to sounds strong enough to induce non-auditory physical effects.

Possible Effects of Other Acoustic Sources

The Kongsberg EM 122 MBES and Knudsen Chirp 3260 SBP would be operated from the source vessel during the proposed survey. Information about this equipment was provided in § 2.2.3.1 of the PEIS. A review of the expected potential effects (or lack thereof) of MBESs, SBPs, and pingers on marine mammals appears in § 3.6.4.3, § 3.7.4.3, and § 3.8.4.3 and Appendix E of the PEIS.

There has been some recent attention given to the effects of MBES on marine mammals, as a result of a report issued in September 2013 by an IWC independent scientific review panel linking the operation of an MBES to a mass stranding of melon-headed whales (*Peponocephala electra*; Southall et al. 2013) off Madagascar. During May–June 2008, ~100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12-kHz MBES survey was being conducted ~65 km away off the coast. In conducting a retrospective review of available information on the event, an independent scientific review panel concluded that the Kongsberg EM 120 MBES was the most plausible behavioral trigger for the animals initially entering the lagoon system and eventually stranding. The independent scientific review panel, however, identified that an unequivocal conclusion on causality of the event was not possible because of the lack of information about the event and a number of potentially contributing factors. Additionally, the independent review panel report indicated that this incident was likely the result of a complicated confluence of environmental, social, and other factors that have a very low probability of occurring again in the future, but recommended that the potential be considered in environmental planning. It should be noted that this event is the first known marine mammal mass stranding closely associated with the operation of an MBES. Leading scientific experts knowledgeable about MBES have expressed concerns about the independent scientific review panel analyses and findings (Bernstein 2013).

Lurton (2015) modeled MBES radiation characteristics (pulse design, source level, and radiation directivity pattern) applied to a low-frequency (12 kHz), 240-dB source-level system like that used on the *Langseth*. Using Southall et al. (2007) thresholds, he found that injury impacts were possible only at very short distances, e.g., at 5 m for maximum SPL and 12 m for cumulative SEL for cetaceans; corresponding distances for behavioural response were 9 m and 70 m. For pinnipeds, "all ranges are multiplied by a factor of 4" (Lurton 2015:209).

There is no available information on marine mammal behavioral response to MBES sounds (Southall et al. 2013). Much of the literature on marine mammal response to sonars relates to the types of sonars used in naval operations, including Low-Frequency Active (LFA) sonars (e.g., Miller et al. 2012; Sivle et al. 2012) and Mid-Frequency Active (MFA) sonars (e.g., Tyack et al. 2011; Melcón et al. 2012; Miller et al. 2012; DeRuiter et al. 2013a,b; Goldbogen et al. 2013; Baird et al. 2014; Wensveen et al. 2015). However, the MBES sounds are quite different from naval sonars. Ping duration of the MBES is very short relative to naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; naval sonars often use near-horizontally-directed sound. In addition, naval sonars have higher duty cycles. These factors would all reduce the sound energy received from the MBES relative to that from naval sonars.

In the fall of 2006, an Ocean Acoustic Waveguide Remote Sensing (OAWRS) experiment was carried out in the Gulf of Maine (Gong et al. 2014); the OAWRS emitted three frequency-modulated (FM) pulses centered at frequencies of 415, 734, and 949 Hz (Risch et al. 2012). Risch et al. (2012)

found a reduction in humpback whale song in the Stellwagen Bank National Marine Sanctuary during OAWRS activities that were carried out ~200 km away; received levels in the sanctuary were 88–110 dB re 1 µPa. In contrast, Gong et al. (2014) reported no effect of the OAWRS signals on humpback whale vocalizations in the Gulf of Maine. Range to the source, ambient noise, and/or behavioral state may have differentially influenced the behavioral responses of humpbacks in the two areas (Risch et al. 2014).

Deng et al (2014) measured the spectral properties of pulses transmitted by three 200-kHz echosounders, and found that they generated weaker sounds at frequencies below the center frequency (90–130 kHz). These sounds are within the hearing range of some marine mammals, and the authors suggested that they could be strong enough to elicit behavioral responses within close proximity to the sources, although they would be well below potentially harmful levels. Hastie et al. (2014) reported behavioral responses by grey seals to echosounders with frequencies of 200 and 375 kHz.

Despite the aforementioned information that has recently become available, and in agreement with § 3.6.7, 3.7.7, and 3.8.7 of the PEIS, the operation of MBESs, SBPs, and pingers is not likely to impact marine mammals, (1) given the lower acoustic exposures relative to airguns and (2) because the intermittent and/or narrow downward-directed nature of these sounds would result in no more than one or two brief ping exposures of any individual marine mammal given the movement and speed of the vessel.

Other Possible Effects of Seismic Surveys

Other possible effects of seismic surveys on marine mammals include masking by vessel noise, disturbance by vessel presence or noise, and injury or mortality from collisions with vessels or entanglement in seismic gear.

Vessel noise from the *Langseth* could affect marine animals in the proposed survey area. Sounds produced by large vessels generally dominate ambient noise at frequencies from 20 to 300 Hz (Richardson et al. 1995). However, some energy is also produced at higher frequencies (Hermannsen et al. 2014); low levels of high-frequency sound from vessels has been shown to elicit responses in harbor porpoise (Dyndo et al. 2015). Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (Branstetter et al. 2013; Finneran and Branstetter 2013). Branstetter et al. (2013) reported that time-domain metrics are also important in describing and predicting masking. In order to compensate for increased ambient noise, some cetaceans are known to increase the source levels of their calls in the presence of elevated noise levels from shipping, shift their peak frequencies, or otherwise change their vocal behavior (e.g., Parks et al. 2011; 2012; Castellote et al. 2012; Melcón et al. 2012; Tyack and Janik 2013; Luís et al. 2014; Sairanen 2014; Papale et al. 2015). Holt et al. (2015) reported that changes in vocal modifications can have increased energetic costs for individual marine mammals.

Baleen whales are thought to be more sensitive to sound at these low frequencies than are toothed whales (e.g., MacGillivray et al. 2014), possibly causing localized avoidance of the proposed survey area during seismic operations. Reactions of gray and humpback whales to vessels have been studied, and there is limited information available about the reactions of right whales and rorquals (fin, blue, and minke whales). Reactions of humpback whales to boats are variable, ranging from approach to avoidance (Payne 1978; Salden 1993). Baker et al. (1982, 1983) and Baker and Herman (1989) found humpbacks often move away when vessels are within several kilometers. Humpbacks seem less likely to react overtly when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984, 1986).

Many odontocetes show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, if previously harassed by vessels, or have had little or no recent exposure to ships (Richardson et al. 1995). Dolphins of many species tolerate and sometimes approach vessels. Some dolphin species approach moving vessels to ride the bow or stern waves (Williams et al. 1992). Pirotta et al. (2015) noted that the physical presence of vessels, not just ship noise, disturbed the foraging activity of bottlenose dolphins. There are few data on the behavioral reactions of beaked whales to vessel noise, though they seem to avoid approaching vessels (e.g., Würsig et al. 1998) or dive for an extended period when approached by a vessel (e.g., Kasuya 1986). Based on a single observation, Aguilar Soto et al. (2006) suggested that foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels.

The PEIS concluded that project vessel sounds would not be at levels expected to cause anything more than possible localized and temporary behavioral changes in marine mammals, and would not be expected to result in significant negative effects on individuals or at the population level. In addition, in all oceans of the world, large vessel traffic is currently so prevalent that it is commonly considered a usual source of ambient sound.

Another concern with vessel traffic is the potential for striking marine mammals. Information on vessel strikes is reviewed in § 3.6.4.4 and § 3.8.4.4 of the PEIS. The PEIS concluded that the risk of collision of seismic vessels or towed/deployed equipment with marine mammals exists but is extremely unlikely, because of the relatively slow operating speed (typically 7–9 km/h) of the vessel during seismic operations, and the generally straight-line movement of the seismic vessel. There has been no history of marine mammal vessel strikes with the R/V *Langseth*, or its predecessor, R/V *Maurice Ewing* over the last two decades.

Numbers of Marine Mammals that could be "Taken by Harassment"

All expected takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied would minimize the possibility of injurious takes. (However, as noted earlier and in the PEIS, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate the number of potential exposures to sound levels >160 dB re 1 μPa_{rms} and present estimates of the numbers of marine mammals that could be affected during the proposed seismic survey. The estimates are based on consideration of the number of marine mammals that could be disturbed appreciably by ~3263 km of seismic surveys in the South Atlantic Ocean. The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

It is assumed that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES and SBP would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES and SBP, given their characteristics (e.g., narrow downward-directed beam) and other considerations described in § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS. Such reactions are not considered to constitute "taking" (NMFS 2001). Therefore, no additional allowance is included for animals that could be affected by sound sources other than airguns.

Basis for Estimating Take

The estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array where received levels of sound >160 dB re 1 μPa_{rms} are predicted to occur (see Table 1). The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach an operating airgun array, these estimates likely overestimate the numbers actually exposed to the specified level of sound.

The overestimation is expected to be particularly large when dealing with the higher sound-level criteria, e.g., 180 dB re 1 μPa_{rms}, as animals are more likely to move away before received levels reach 180 dB than they are to move away before it reaches (for example) 160 dB re 1 μPa_{rms}. Likewise, they are less likely to approach within the ≥180- or 190-dB re 1 μPa_{rms} radii than they are to approach within the considerably larger ≥160 dB radius.

Density estimates are not available for the proposed survey area. Thus, we have applied density estimates available from the regions nearest to the proposed survey area to species expected to be uncommon there. No marine mammal species are expected to be common in the proposed survey area; density estimates are considered to be zero for species expected to be rare. Densities for sei, fin, sperm, Cuvier's beaked, and long-finned pilot whales, and for the southern right whale dolphin are based on density estimates calculated by AECOM (2014) for an NSF marine geophysical survey in the Scotia Sea and South Atlantic Ocean at ~53–58°S, 30–40°W; densities were from the Navy Marine Species Density Database (NMSDD).

The density estimate for rough-toothed dolphins is based on sightings during shipboard winter surveys along a coastal-offshore gradient in the Vitória-Trindade Chain, western South Atlantic Ocean, during August–September 2010 (Wedekin et al. 2014). The density estimates for pantropical spotted dolphin and short-finned pilot whale are based on sightings on vessel surveys off Gabon between March and August 2009 (de Boer 2010). We calculated densities using standard line-transect methods (Buckland et al. 2001); densities were corrected for trackline lateral detection probability bias [$f(0)$] and availability [$g_a(0)$] and detectability [$g_d(0)$] biases from Forney and Barlow (1998). Density estimates for three uncommon species (short-beaked common and Fraser's dolphins, and pygmy killer whale) are not available as no sightings have been reported during systematic surveys in the South Atlantic Ocean; therefore, densities for these species are assumed to be zero. Species classified as rare in Table 2 that are not listed as ***Endangered*** under the ESA (see Table 1), or for which there are no confirmed sightings in or reasonably near the survey area in the OBIS database (OBIS 2015), are not included in Table 3.

There is some uncertainty about the representativeness of the estimated density data and the assumptions used in the calculations. Notably, the calculated density estimates originate from different surveys covering various seasons and different regions, some >3000 km away from the proposed survey area. However, the approach used here is based on the best available data, and the calculated exposures that are based on these densities are best estimates for the proposed survey for any time of the year.

The estimated numbers of individuals that may be "taken by harassment" (Level B takes) are based on the 160-dB re 1 μPa_{rms} criterion for all cetaceans and pinnipeds. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently. Although injurious or lethal takes are considered extremely unlikely because of marine mammal avoidance of loud sounds and the proposed mitigation and monitoring measures, exposures to received levels >180-dB re 1 μPa_{rms} (Level A criterion for cetaceans) were also determined; pinnipeds are considered to be rare in the proposed survey area.

TABLE 3. Densities and estimates of the possible numbers of individuals that could be exposed to ≥160 and ≥180 dB re 1 µPa_{rms} during the proposed seismic survey in the South Atlantic Ocean during austral summer 2016. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in^3. Species in italics are listed under the ESA as endangered. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

			Takes using NMFS Methodology[2]		Calculated Take[3]			
Species	Reported Density (#/1000 km^2)	Estimated Density (#/1000 km^2)[1]	Level A (≥180 dB)	Level B (≥160 dB)	Level A (≥180 dB)	Level B (≥160 dB)	% of Regional Pop'n[4]	Requested Level B Take Authoriza-tion
Mysticetes								
Southern right whale	*0*	*0*	*0*	*0*	*0*	*0*	*0*	***2***[5]
Humpback whale	*0*	*0*	*0*	*0*	*0*	*0*	*0*	***2***[5]
Sei whale	*6.36*[6]	*6.36*[6]	*65*	*404*	*44*	*263*	*2.6*	***263***
Fin whale	*18.2*[6]	*18.2*[6]	*186*	*1157*	*125*	*754*	*5.0*	***754***
Blue whale	*0*	*0*	*0*	*0*	*0*	*0*	*0*	***1***[5]
Odontocetes								
Sperm whale	*2.07*[6]	*2.07*[6]	*21*	*132*	*14*	*86*	*0.8*	***86***
Cuvier's beaked whale	0.55[6]	0.55[6]	6	35	4	23	0	**23**
Southern bottlenose whale	0	0	0	0	0	0	0	**2**[7]
Rough-toothed dolphin	5.95[8]	5.95[8]	61	379	41	247	N/A	**247**
Pantropical spotted dolphin	3.77[9]	3.77[9]	38	240	26	156	N/A	**156**
Short-beaked common dolphin	0	0	0	0	0	0	N/A	**88**[10]
Fraser's dolphin	0	0	0	0	0	0	N/A	**440**[10]
Southern right whale dolphin	6.16[6]	6.16[6]	63	392	42	255	N/A	**255**
Pygmy killer whale	0	0	0	0	0	0	N/A	**30**[10]
Killer whale	0	0	0	0	0	0	0	**4**[7]
Long-finned pilot whale	214.6[6]	214.6[6]	2188	13642	1471	8884	4.4	**8884**
Short-finned pilot whale	2.09[9]	2.09[9]	21	133	14	86	N/A	**86**
Pinnipeds								
Southern elephant seal	0	0	N/A	0	N/A	0	0	**2**[7]

N/A = not available or not applicable.

[1] No additional correction factors were applied for these calculations.

[2] NMFS-prescribed methodology for calculated take is estimated density multiplied by the daily ensonified area assuming 200 km of survey/day multiplied by the number of seismic days, including 25% contingency (see NMFS 2015c); ≥160-dB ensonified area = 63,580 km^2; ≥180-dB ensonified area = 10,197 km^2.

[3] Calculated take is estimated density multiplied by the GIS-calculated ensonified area without overlap, including 25% contingency; ≥160-dB ensonified area = 41,406 km^2; ≥180-dB ensonified area = 6854 km^2.

[4] Requested takes (of individuals) expressed as percentages of the populations.

[5] For rare species listed as ***endangered*** under the ESA, the requested take authorization was increased to mean group size off the Antarctic Peninsula and South Georgia for southern right and humpback whales (Williams et al. 2006), and for the MAR in the North Atlantic for blue whales (Waring et al. 2008).

[6] Densities estimated by AECOM (2014) for the Scotia Sea and South Atlantic Ocean.

[7] For rare species with sightings near the survey area in the OBIS database (OBIS 2015), requested take authorization was increased to mean group size off the Antarctic Peninsula and South Georgia for southern bottlenose and killer whales (Williams et al. 2006), and to mean group size of the three nearest records to the survey area for southern elephant seals (Lewis et al. 2006b).

[8] Densities estimated from Wedekin et al. (2014) for the western South Atlantic Ocean (see text).

[9] Densities estimated from de Boer (2010) off Gabon (see text).

[10] For uncommon species with no density estimate available, requested take authorization increased to mean group size off northern Angola for short-beaked common dolphin (Weir 2007a), and in the eastern tropical Pacific for Fraser's dolphin and pygmy killer whale (Ferguson et al. 2006).

Table 3 shows the density estimates calculated as described above and the estimates of the number of different individual marine mammals that potentially could be exposed to ≥160 dB and ≥180 dB re 1 μPa_{rms} during the seismic survey if no animals moved away from the survey vessel. The *Requested Take Authorization* for Level B takes is given in the far right column of Table 3. For uncommon species for which densities were not available, and for rare species listed as ***Endangered*** under the ESA or for which there are confirmed sightings in or reasonably near the survey area in the OBIS database (OBIS 2015), we have included a *Requested Take Authorization* for the mean group size for the species at the nearest available location (see Table 3 for sources).

It should be noted that the following estimates of exposures assume that the proposed survey would be completed; in fact, the ensonified area calculated using the planned number of line-kilometers ***has been increased by 25%*** to accommodate turns, lines that may need to be repeated, equipment testing, etc. As is typical during offshore seismic surveys, inclement weather and equipment malfunctions likely would cause delays and might limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated EZ would result in the shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 μPa_{rms} sounds are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely.

Consideration should be given to the hypothesis that delphinids are less responsive to airgun sounds than are mysticetes, as referenced in both the PEIS and § 4.1.1.1 of this document. The 160-dB(rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. The estimates of "takes by harassment" of delphinids are thus considered precautionary. As noted previously, in July 2015, NOAA made available for a second public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2015), although at the time of preparation of this Draft EA, the date of release of the final guidelines and how they would be implemented are unknown. Available data suggest that the current use of a 160-dB criterion could be improved upon, as behavioral response might not occur for some percentage of marine mammals exposed to received levels >160 dB, whereas other individuals or groups might respond in a manner considered as "taken" to sound levels <160 dB (NMFS 2013c). It has become evident that the context of an exposure of a marine mammal to sound can affect the animal's initial response to the sound (NMFS 2013c).

NMFS does not provide specific guidance or requirements for IHA Applicants or for Section 7 ESA consultation for the development of take estimates and multiple exposure analysis, therefore variation in methodologies and calculations are likely to occur. Here we follow a methodology that has been used successfully for past NSF seismic surveys to generate take estimates for the MMPA and ESA processes. That method uses GIS to calculate ensonified areas using the geometry of the survey and the modeled propagation distances. However, as requested by NMFS, we also present in Table 3 the results using their methodology (see footnote 2 in Table 3).

Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds with received levels ≥160 dB re 1 μPa_{rms} on one or more occasions can be estimated by considering the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion, along with the expected density of animals in the area. The number of possible exposures (including repeated exposures of the same individuals) can be estimated by considering the total marine area that would be within the 160-dB radius around the operating airguns, including areas of overlap. During the proposed primary survey in the South Atlantic Ocean, the area including overlap is ~1.2 times the area excluding overlap, so a marine mammal that stayed in that survey area during the survey would typically be exposed only once, on average. It is unlikely that a particular animal would stay in the area during the entire survey. The numbers of different individuals potentially exposed to ≥160 dB re 1 μPa_{rms} were calculated by multiplying the expected species density times the anticipated area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by "drawing" the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

Applying the approach described above, ~33,125 km^2 (41,406 km^2 including the 25% contingency) would be within the 160-dB isopleth on one or more occasions in the South Atlantic Ocean during the proposed survey. Because this approach does not allow for turnover in the mammal populations in the area during the course of the survey, the actual number of individuals exposed could be underestimated, although the conservative (i.e., probably overestimated) line-kilometer distances used to calculate the area could offset this. Also, the approach assumes that no cetaceans would move away or toward the trackline in response to increasing sound levels before the levels reach 160 dB as the *Langseth* approaches. Another way of interpreting the estimates is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to ≥160 dB re 1 μPa_{rms}.

The estimate of the number of individual marine mammals that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa_{rms} during the proposed survey is 10,754 (Table 3). That total includes 1103 cetaceans listed as ***Endangered*** under the ESA: 86 sperm whales, 754 fin whales, and 263 sei whales, representing 0.8%, 5.0%, and 2.6% of their regional populations (also see Table 2), respectively. In addition, 23 Cuvier's beaked whales could be exposed during the survey (Table 3). Most (89.5%) of the cetaceans potentially exposed would be delphinids; the long-finned pilot whale, southern right whale dolphin, rough-toothed dolphin, and pantropical spotted dolphin, are expected to be the most common delphinid species in the area, with estimates of 8884 (4.4% of the regional population), 255, 247, and 156 exposed to ≥160 dB re 1 μPa_{rms}, respectively.

Conclusions

The proposed seismic project would involve towing a 36-airgun array with a total discharge volume of 6600 in^3 that introduces pulsed sounds into the ocean. Routine vessel operations, other than the proposed seismic operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking". In § 3.6.7, § 3.7.7, and § 3.8.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures could result in a small number of Level B behavioral effects in some mysticete, odontocete, and pinniped species and that Level A effects were highly unlikely.

Estimates of the numbers of marine mammals that could be exposed to airgun sounds during the proposed program have been presented, together with the requested "take authorization". The estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are low percentages of the regional population sizes (Table 3). The estimates are likely overestimates of the actual number of animals that would be exposed to and would react to the seismic sounds. The reasons for that conclusion are outlined above. The relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations. Therefore, no significant impacts on cetaceans or pinnipeds would be expected from the proposed activity.

In decades of seismic surveys carried out by the *Langseth* and its predecessor, the R/V *Ewing*, PSOs and other crew members have seen no seismic sound-related marine mammal injuries or mortality. Also, actual numbers of animals potentially exposed to sound levels sufficient to cause disturbance (i.e., are considered takes) have almost always been much lower than predicted and authorized takes. For example, during an NSF-funded, ~5000-km, 2-D seismic survey conducted by the *Langseth* off the coast of North Carolina in September–October 2014, only 296 cetaceans were observed within the predicted 160-dB zone and potentially taken, representing <2% of the 15,498 takes authorized by NMFS (RPS 2015). During an USGS-funded, ~2700 km, 2-D seismic survey conducted by the *Langseth* along the U.S. east coast in August–September 2014, only 3 unidentified dolphins were observed within the predicted 160-dB zone and potentially taken, representing <0.03% of the 11,367 authorized takes (RPS 2014).

VIII. ANTICIPATED IMPACT ON SUBSISTENCE

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

There is no subsistence hunting near the proposed survey area, so the proposed activity would not have any impact on the availability of the species or stocks for subsistence users.

IX. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity would be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in § VII, above.

Effects of seismic sound on marine invertebrates (crustaceans and cephalopods), marine fish, and their fisheries are discussed in § 3.2.4 and § 3.3.4 and Appendix D of the PEIS. The PEIS concluded that there could be changes in behavior and other non-lethal, short-term, temporary impacts, and injurious or mortal impacts on a small number of individuals within a few meters of a high-energy acoustic source, but that there would be no significant impacts of NSF-funded marine seismic research on populations.

X. ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations would be limited in duration. However, a small minority of the marine mammals that are present near the proposed activity may be temporarily displaced as much as a few kilometers by the planned activity.

XI. MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Marine mammals and sea turtles are known to occur in the proposed survey area. To minimize the likelihood that impacts would occur to the species and stocks, airgun operations would be conducted in accordance with the MMPA and the ESA, including obtaining permission for incidental harassment or incidental 'take' of marine mammals and other endangered species. The proposed activity would take place in International Waters in the South Atlantic Ocean.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activity. The procedures described here are based on protocols used during previous L-DEO seismic research cruises as approved by NMFS, and on best practices recommended in Richardson et al (1995), Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Planning Phase

As discussed in § 2.4.1.1 of the PEIS, mitigation of potential impacts from the proposed activity begins during the planning phase of the proposed activity. Several factors were considered during the planning phase of the proposed activity, including

1. *Energy Source*—Part of the considerations for the proposed marine seismic survey was to evaluate whether the research objectives could be met with a smaller energy source than the full 36-airgun, 6600-in^3 *Langseth* array, and it was decided that the scientific objectives for the survey could not be met using a smaller source as they would lack the energy and low-frequency content to penetrate deep into the igneous crust.
2. *Survey Timing*—The PIs worked with L-DEO and NSF to identify potential times to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment, and optimal timing for other proposed seismic surveys using the *Langseth*. Most marine mammal species are expected to occur in the area year-round, although some migratory baleen whales are expected to occur farther south at the time of the survey. Thus, altering the timing of the proposed project likely would result in no net benefits for marine mammals.
3. *Mitigation Zones*—During the planning phase, mitigation zones for the proposed survey were calculated based on modeling by L-DEO for both the EZ and the safety zone; these zones are given in Table 1. The proposed survey would acquire data with the 36-airgun array at a tow depth of 9 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m. A more detailed description of the modeling process used to develop the mitigation zones can be found in § I.

   Table 1 shows the 180-dB EZ and 160-dB "Safety Zone" (distances at which the rms sound levels are expected to be received) for the mitigation airgun and the 36-airgun array. The 160- and 180-dB re 1 μPa_{rms} distances are the criteria currently specified by NMFS (2000) for cetaceans. Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In July 2015, NOAA published a revised version of its 2013 draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2015), although at the time of preparation of this application, the date of release of the final guidelines and how they will be implemented are unknown.

The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs. Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as noted below.

Mitigation During Operations

Mitigation measures that would be adopted during the proposed survey include (1) power-down procedures, (2) shut-down procedures, and (3) ramp-up procedures.

Power-down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that marine mammals or turtles are no longer in or about to enter the EZ. The acoustic source would also be powered down in the event an ESA-listed seabird were observed diving or foraging within the designated EZ. During a power down, one airgun would be operated. The continued operation of one airgun is intended to alert marine mammals and turtles to the presence of the seismic vessel in the area. In contrast, a shut down occurs when all airgun activity is suspended.

If a marine mammal or turtle is detected outside the EZ but is likely to enter the EZ, the airguns would be powered down before the animal is within the EZ. Likewise, if a mammal or turtle is already within the EZ when first detected, the airguns would be powered down immediately. During a power down of the airgun array, the 40-in^3 airgun would be operated. If a marine mammal or turtle is detected within or near the smaller EZ around that single airgun (Table 1), it would be shut down (see next subsection).

Following a power down, airgun activity would not resume until the marine mammal or turtle has cleared the safety zone. The animal would be considered to have cleared the safety zone if

- it is visually observed to have left the EZ, or
- it has not been seen within the zone for 15 min in the case of small odontocetes, or
- it has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales, or
- the vessel has moved outside the EZ for turtles, e.g., if a turtle is sighted close to the vessel and the ship speed is 8.3 km/h, it would take the vessel ~15 min to leave the turtle behind.

During airgun operations following a shut down whose duration has exceeded the time limits specified above, the airgun array would be ramped up gradually. Ramp-up procedures are described below. During past *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity. Furthermore, under these circumstances, ramp-up procedures may unnecessarily extend the length of the survey time needed to collect seismic data. L-DEO and NSF have concluded in consultation with NMFS that ramp up is not necessary after an extended power down. Therefore, this practice is not included here as part of the monitoring and mitigation plan.

Shut-down Procedures

The operating airgun(s) would be shut down if a marine mammal or turtle is seen within or approaching the EZ for the single airgun. The operating airgun(s) would also be shut down in the event an ESA-listed seabird were observed diving or foraging within the designated EZ.

Shut downs would be implemented (1) if an animal enters the EZ of the single airgun after a power down has been initiated, or (2) if an animal is initially seen within the EZ of the single airgun when more than one airgun (typically the full array) is operating. Airgun activity would not resume until the marine mammal or turtle has cleared the safety zone, or until the protected species observer (PSO) is confident that the animal has left the vicinity of the vessel. Criteria for judging that the animal has cleared the safety zone would be as described in the preceding subsection.

Ramp-up Procedures

A ramp-up procedure would be followed when the airgun array begins operating after a specified period without airgun operations. It is proposed that, for the present survey, this period would be ~8 min. Similar periods (~8–10 min) were used during previous L-DEO surveys. Ramp up would not occur if a marine mammal or sea turtle has not cleared the safety zone as described earlier.

Ramp up would begin with the smallest airgun in the array (40 in^3). Airguns would be added in a sequence such that the source level of the array would increase in steps not exceeding 6 dB per 5-min period. During ramp up, the PSOs would monitor the EZ, and if marine mammals or turtles are sighted, a power down or shut down would be implemented as though the full array were operational.

If the complete EZ has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, ramp up would not commence unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the airgun array would not be ramped up from a complete shut down at night or in thick fog, because the outer part of the safety zone for that array would not be visible during those conditions. If one airgun has operated during a power-down period, ramp up to full power would be permissible at night or in poor visibility, on the assumption that marine mammals and turtles would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. Ramp up of the airguns would not be initiated if a sea turtle or marine mammal is sighted within or near the applicable EZs during the day or night.

As noted above under “Power-down Procedures”, during past R/V *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Currently, under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity and therefore ramp-up is viewed unnecessary.

XII. PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

Not applicable. The proposed activity would take place in the South Atlantic Ocean, and no activities would take place in or near a traditional Arctic subsistence hunting area.

XIII. MONITORING AND REPORTING PLAN

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding...

L-DEO proposes to sponsor marine mammal monitoring during the present project, in order to implement the proposed mitigation measures that require real-time monitoring and to satisfy the expected monitoring requirements of the IHA. L-DEO's proposed Monitoring Plan is described below. L-DEO understands that this Monitoring Plan would be subject to review by NMFS, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. L-DEO is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

Observations by PSOs would take place during daytime airgun operations and nighttime start ups of the airguns. Airgun operations would be suspended when marine mammals, turtles, or diving ESA-listed seabirds are observed within, or about to enter, designated EZs [see § XI above] where there is concern about potential effects on hearing or other physical effects. PSOs would also watch for marine mammals and sea turtles near the seismic vessel for at least 30 min prior to the planned start of airgun operations. Observations would also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits. PSOs would also watch for any potential impacts of the acoustic sources on fish.

During seismic operations, four visual PSOs would be based aboard the *Langseth*. All PSOs would be appointed by L-DEO with NMFS concurrence. During the majority of seismic operations, two PSOs would monitor for marine mammals and sea turtles around the seismic vessel. Use of two simultaneous observers would increase the effectiveness of detecting animals around the source vessel. However, during meal times, only one PSO may be on duty. PSO(s) would be on duty in shifts of duration no longer than 4 h. Other crew would also be instructed to assist in detecting marine mammals and turtles and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew would be given additional instruction regarding how to do so.

The *Langseth* is a suitable platform for marine mammal and turtle observations. When stationed on the observation platform, the eye level would be ~21.5 m above sea level, and the observer would have a good view around the entire vessel. During daytime, the PSO(s) would scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon), Big-eye binoculars (25×150), and with the naked eye. During darkness, night vision devices (NVDs) would be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), when required. Laser rangefinding binoculars (Leica LRF 1200 laser rangefinder or equivalent) would be available to assist with distance estimation. Those are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars.

Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) would take place to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustical monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring would serve to alert visual PSOs (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals call, but it can be effective either by day or by night, and does not depend on good visibility. It would be monitored in real time so that the visual observers can be advised when cetaceans are detected.

The PAM system consists of hardware (i.e., hydrophones) and software. The "wet end" of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m long, and the hydrophones are fitted in the last 10 m of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths <20 m. The array would be deployed from a winch located on the back deck. A deck cable would connect the tow cable to the electronics unit in the main computer lab where the acoustic station, signal conditioning, and processing system would be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Pamguard software. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One acoustic PSO, in addition to the four visual PSOs, would be on board. The towed hydrophones would ideally be monitored 24 h per day while at the seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. One PSO would monitor the acoustic detection system at any one time, by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The PSO monitoring the acoustical data would be on shift for 1–6 h at a time. All observers are expected to rotate through the PAM position, although the most experienced with acoustics would be on PAM duty more frequently.

When a vocalization is detected while visual observations are in progress, the acoustic PSO would contact the visual PSO immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), and to allow a power or shut down to be initiated, if required. The information regarding the call would be entered into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information. The acoustic detection could also be recorded for further analysis.

PSO Data and Documentation

PSOs would record data to estimate the numbers of marine mammals, turtles, and diving ESA-listed seabirds exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. They would also record any observations of fish potentially affected by the sound sources. Data would be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They would also provide information needed to order a power or shut down of the airguns when a marine mammal, sea turtle, or diving ESA-listed seabird is within or near the EZ.

When a sighting is made, the following information about the sighting would be recorded:

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

The data listed under (2) would also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

All observations and power or shut downs would be recorded in a standardized format. Data would be entered into an electronic database. The accuracy of the data entry would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures would allow initial summaries of data to be prepared during and shortly after the field program, and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations would provide

1. the basis for real-time mitigation (airgun power down or shut down);
2. information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS;
3. data on the occurrence, distribution, and activities of marine mammals, turtles, and diving ESA-listed seabirds in the area where the seismic study is conducted;
4. information to compare the distance and distribution of marine mammals, turtles, and diving ESA-listed seabirds relative to the source vessel at times with and without seismic activity;
5. data on the behavior and movement patterns of marine mammals and turtles seen at times with and without seismic activity; and
6. any observations of fish potentially affected by the sound sources.

A report would be submitted to NMFS and NSF within 90 days after the end of the cruise. The report would describe the operations that were conducted and sightings of marine mammals, turtles, and diving ESA-listed seabirds near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, all marine mammal, turtle, and diving ESA-listed seabird sightings (dates, times, locations, activities, associated seismic survey activities), and any observations of fish potentially affected by the sound sources. The report would also include estimates of the number and nature of exposures that could result in "takes" of marine mammals by harassment or in other ways.

XIV. Coordinating Research to Reduce and Evaluate Incidental Take

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

L-DEO and NSF would coordinate with applicable U.S. agencies (e.g., NMFS) and would comply with their requirements.

XV. Literature Cited

AECOM. 2014. Request by the National Science Foundation for an Incidental Harassment Authorization to allow the incidental take of marine mammals during a marine geophysical survey by the R/VIB *Nathaniel B. Palmer* in the Scotia Sea and South Atlantic Ocean. Rep. from AECOM, Alexandria, VA. Submitted 10 June 2014 to the National Marine Fisheries Service Office of Protected Resources, Silver Spring, MD by the National Science Foundation Division of Polar Programs (PLR), Arlington, VA, the Antarctic Support Contract, Centennial, CO, the University of Texas at Austin Institute for Geophysics, Austin, TX, and the University of Memphis, Memphis, TN. 50 p.

Aguilar, A. 2009. Fin whale *Balaenoptera physalus*. p. 433-437 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Aguilar Soto, N., M. Johnson, P.T. Madsen, P.L. Tyack, A. Bocconcelli, and J.F. Borsani. 2006. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (*Ziphius cavirostris*)? **Mar. Mamm. Sci.** 22(3):690-699.

Andriolo, A., C.C.A. Martins, M.H. Engel, J.L. Pizzorno, S. Más-Rosa, A.C. Freitas, M.E. Morete, and P.G. Kinas. 2006. The first aerial survey to estimate abundance of humpback whales (*Megaptera novaeangliae*) in the breeding ground off Brazil (Breeding Stock A). **J. Cetac. Res. Manage.** 8(3):307-311.

Andriolo, A., P.G. Kinas, M.H. Engel, C.C. Albuquerque Martins, and A.M. Rufino. 2010. Humpback whales within the Brazilian breeding group: distribution and population size estimate. **Endang. Spec. Res.** 11(3):233-243.

Arnould, J.P.Y. 2009. Southern fur seals *Arctocephalus* spp. p. 1079-1087 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Atkinson, S., D. Crocker, D. Houser, and K. Mashburn. 2015. Stress physiology in marine mammals: how well do they fit the terrestrial model? **J. Comp. Physiol. B** 185(5):463-486. doi:10.1007/s00360-015-0901-0.

Baird, R.W. 2009. False killer whale *Pseudorca crassidens*. p. 405-406 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Baird, R.W., S.W. Martin, D.L. Webster, and B.L. Southall. 2014. Assessment of modeled received sound pressure levels and movements of satellite-tagged odontocetes exposed to mid-frequency active sonar at the Pacific Missile Range Facility: February 2011 through February 2013. Prepared for U.S. Pacific Fleet, submitted to NAVFAC PAC by HDR Environmental, Operations and Construction, Inc. Accessed on 13 March 2015 at www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA602847.

Baker, A.N. 1985. Pgymy right whale *Caperea marginata* (Gray 1846). p. 345-354 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 3: The Sirenians and baleen whales. Academic Press, London, U.K. 362 p.

Baker, A.N. 2001. Status, relationships, and distribution of *Mesoplodon bowdoini* Andrews, 1908 (Cetacea: Ziphiidae). **Mar. Mamm. Sci.** 17(3):473-493.

Baker, C.S. and L.M. Herman. 1989. Behavioral responses of summering humpback whales to vessel traffic: experimental and opportunistic observations. NPS-NR-TRS-89-01. Rep. from Kewalo Basin Mar. Mamm. Lab., Univ. Hawaii, Honolulu, HI, for U.S. Natl. Park Serv., Anchorage, AK. 50 p. NTIS PB90-198409.

Baker, C.S., L.M. Herman, B.G. Bays, and W.F. Stifel. 1982. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska. Rep. from Kewalo Basin Mar. Mamm. Lab., Honolulu, HI, for U.S. Nat. Mar. Fish. Serv., Seattle, WA. 78 p.

Baker, C.S., L.M. Herman, B.G. Bays, and G.B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. Rep. from Kewalo Basin Mar. Mamm. Lab., Honolulu, HI, for U.S. Nat. Mar. Mamm. Lab., Seattle, WA. 30 p.

Baker, C.S., L. Flórez-González, B. Abernethy, H.C. Rosenbaum, R.W. Slade, J. Capella, and J.L. Bannister. 1998. Mitochondrial DNA variation and maternal gene flow among humpback whales of the Southern Hemisphere. **Mar. Mamm. Sci.** 14(4):721-737.

Barendse, J. and P.B. Best. 2014. Shore-based observations of seasonality, movements, and group behaviour of southern right whales in a nonnursery area on the South African west coast. **Mar. Mamm. Sci.** 30(4):1358-1382.

Barendse J., P. Best, M. Thornton, C. Pomilla, I. Carvalho, and H.C. Rosenbaum. 2010. Migration redefined? Seasonality, movements, and group composition of humpback whales *Megaptera novaeangliae* off the west coast of South Africa. **African J. Mar. Sci.** 32(1):1-22.

Barros, N.B., D.A. Duffield, P.H. Ostrom, D.K. Odell, and V.R. Cornish. 1998. Nearshore vs. offshore ecotype differentiation of *Kogia breviceps* and *K. simus* based on hemoglobin, morphometric and dietary analyses. Abstr. World Mar. Mamm. Sci. Conf., 20–24 January, Monaco.

Barry, S.B., A.C. Cucknell, and N. Clark. 2012. A direct comparison of bottlenose dolphin and common dolphin behaviour during seismic surveys when airguns are and are not being utilised. p. 273-276 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Bernstein, L. 2013. The Washington Post: Health, Science, and Environment. Panel links underwater mapping sonar to whale stranding for first time. Published 6 October 2013. Accessed on 11 June 2015 at http://www.washingtonpost.com/national/health-science/panel-links-underwater-mapping-sonar-to-whale-stranding-for-first-time/2013/10/06/52510204-2e8e-11e3-bbed-a8a60c601153_story.html.

Best, P.B. 2001. Distribution and population separation of Bryde's whale *Balaenoptera edeni* off southern Africa. **Mar. Ecol. Prog. Ser.** 220:277-289.

Best, P.B. 2007. Whales and dolphins of the southern African subregion. Cambridge University Press, Cape Town, South Africa. 338 p.

Best, P.B. and C.H. Lockyer. 2002. Reproduciton, growth and migrations of sei whales *Balaenoptera borealis* off the west coast of South Africa. **S. Afr. J. Mar. Sci.** 24(1):111-133.

Best, P.B. and M.J. Roscoe. 1974. Survey of right whales off South Africa 1972, with observations from Tristan da Cunha, 1971/1972. **Rep. Int. Whal. Comm.** 24:136-141.

Best, P.B., R. Payne, V. Rowntree, J. Truda Palazoo, and M.D.C. Both. 1993. Long-range movements of South Atlantic right whales *Eubalaena australis*. **Mar. Mamm. Sci.** 9(3):227-234.

Best, P.B., J.P. Glass, P.G. Ryan, and M.L. Dalebout. 2009. Cetacean records from Tristan da Cunha, South Atlantic. **J. Mar. Biol. Ass. U.K.** 89(5):1023-1032.

Best, P.B., M.J. Smale, J. Glass, K. Herian, and S. Von der Heyden. 2014. Identification of stomach contents from a Shepherd's beaked whale *Tasmacetus shepherdi* stranded on Tristan da Cunha, South Atlantic. **J. Mar. Biol. Assoc. U.K.** 94(6):1093-1097.

Bester M.N. and P.G. Ryan. 2007. Mammals. p. 98–109 *In:* P.G. Ryan (ed.) Field guide to the animals and plants of Tristan da Cunha and Gough Island. Newbury: Pisces Publications for the Tristan Island Government.

Bester, M.N., H. Möller, J. Wium, and B. Enslin. 2001. An update on the status of southern elephant seals at Gough Island. **S. Afr. J. Wildl. Res.** 41(1&2):68-71.

Bester, M.N., J.W. Wilson, M.-H. Burle, and G.J.G. Hofmeyr. 2006. Population trends of Subantarctic fur seals at Gough Island. **S. Afr. J. Wildl. Res.** 36(2):191-194.

Bettridge, S., C.S. Baker, J. Barlow, P.J. Clapham, M. Ford, D. Gouveia, D.K. Mattila, R.M. Pace III, P.E. Rosel, G.K. Silber, and P.R. Wade. 2105. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. NOAA-TM-NMFS-SWFSC-540.

Blackwell, S.B., C.S. Nations, T.L. McDonald, C.R. Greene, Jr., A.M. Thode, M. Guerra, and A.M. Macrander. 2013. Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea. **Mar. Mamm. Sci.** 29(4):E342-E365.

Blackwell, S.B., C.S. Nations, T.L. McDonald, A.M. Thode, D. Mathias, K.H. Kim, C.R. Greene, Jr., and A.M. Macrander. 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. **PLoS ONE** 10(6):e0125720. doi:10.1371/journal.pone.0125720.

Boyd, I.L. 2002. Antarctic marine mammals. p. 30-36 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.) Encyclopedia of Marine Mammals. Academic Press, San Diego, CA. 1414 p.

Branch, T.A., K.M. Stafford, D.M. Palacios, C. Allison, J.L. Bannister, C.L.K. Burton, E. Cabrera, C.A. Carlson, B. Galletti Vernazzani, P.C. Gill, R. Hucke-Gaete, K.C.S. Jenner, M.-N.M. Jenner, K. Matsuoka, Y.A. Mikhalev, T. Miyashita, M.G. Morrice, S. Nishiwaki, V.J. Sturrock, D. Tormosov, R.C. Anderson, A.N. Baker, P.B. Best, P. Borsa, R.L. Brownell Jr, S. Childerhouse, K.P. Findlay, T. Gerrodette, A.D. Ilangakoon, M. Joergensen, B. Kahn, D.K. Ljungblad, B. Maughan, R.D. McCauley, S. Mckay, T.F. Norris, Oman Whale and Dolphin Research Group, S. Rankin, F. Samaran, D. Thiele, K. Van Waerebeek and R.M. Warneke. 2007. Past and present distribution, densities, and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean. **Mamm. Rev.** 37(2):116-175.

Branstetter, B.K., J.S. Trickey, H. Aihara, J.J. Finneran, and T.R. Liberman. 2013. Time and frequency metrics related to auditory masking of a 10 kHz tone in bottlenose dolphins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 134(6):4556-4565.

Breitzke, M. and T. Bohlen. 2010. Modelling sound propagation in the Southern Ocean to estimate the acoustic impact of seismic research surveys on marine mammals. **Geophys. J. Int.** 181(2):818-846.

Broker, K., J. Durinck, C. Vanman, and B. Martin. 2013. Monitoring of marine mammals and the sound scape during a seismic survey in two license blocks in the Baffin Bay, West Greendland, in 2012. p. 32 *In*: Abstr. 20th Bienn. Conf. Biol. Mar. Mamm., 9-13 December 2013, Dunedin, New Zealand. 233 p.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, U.K. 448 p.

Budylenko, G.A. 1981. Distribution and some aspects of the biology of killer whales in the South Atlantic. **Rep. Intern. Whal. Comm.** 31:523-525.

Campagna, C., M.N. Lewis, and M.R. Marin. 2006. Locations of Seals in Patagonian Large Marine Ecosystem. In: Ashore and at sea distribution of seals. Centro Nacional Patagónico, Puerto Madryn, Argentina. Retrieved from http://www.iobis.org.

Carvalho, I., C. Brito, M.E. dos Santos, and H.C. Rosenbaum. 2011. The waters of São Tomé: a calving ground for West African humpback whales? **African J. Mar. Sci.** 33(1):91-97.

Carwardine, M. 1995. Whales, dolphins and porpoises. Dorling Kindersley Publishing, Inc., New York. 256 p.

Castellote, M. and C. Llorens. 2013. Review of the effects of offshore seismic surveys in cetaceans: are mass strandings a possibility? Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Castellote, M., C.W. Clark, and M.O. Lammers. 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. **Biol. Conserv**. 147(1):115-122.

Cato, D.H., M.J. Noad, R.A. Dunlop, R.D. McCauley, C.P. Salgado Kent, N.J. Gales, H. Kniest, J. Noad, and D. Paton. 2011. Behavioral response of Australian humpback whales to seismic surveys. **J. Acoust. Soc. Am.** 129(4):2396.

Cato, D.H., M.J. Noad, R.A. Dunlop, R.D. McCauley, N.J. Gales, C.P. Salgado Kent, H. Kniest, D. Paton, K.C.S. Jenner, J. Noad, A.L. Maggi, I.M. Parnum, and A.J. Duncan. 2012. Project BRAHSS: Behavioural response of Australian humpback whales to seismic surveys. Proc. Austral. Acoust. Soc., 21–23 Nov. 2012, Fremantle, Australia. 7 p.

Cato, D.H, M.J. Noad, R.A. Dunlop, R.D. McCauley, N.J. Gales, C.P. Salgado Kent, H. Kniest, D. Paton, K.C.S. Jenner, J. Noad, A.L. Maggi, I.M. Parnum, and A.J. Duncan. 2013. A study of the behavioural response of whales to the noise of seismic air guns: design, methods and progress. **Acoust. Austral.** 41(1):88-97.

Cauquil, P., J. Barde, C. Rodriguez, E. Chassot, and P. Chavance. 2012. Ecoscope tuna bycatch observer data. Institut de Recherche pour le Developpement (IRD). Retrieved from http://www.iobis.org.

Cerchio, S., S. Strindberg, T. Collins, C. Bennett, and H. Rosenbaum. 2014. Seismic surveys negatively affect humpback whale singing activity off northern Angola. **PLoS ONE** 9(3):e86464. doi:10.1371/journal.pone.0086464.

Clapham, P.J. 2009. Humpback whale *Megaptera novaeangliae*. p. 582-585 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Clark, C.W. and G.C. Gagnon. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. Working Pap. SC/58/E9. Int. Whal. Comm., Cambridge, U.K. 9 p.

Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. **Mar. Ecol. Prog. Ser.** 395:201-222.

Clarke, M. and N. Goodall. 1994. Cephalopods in the diets of three odontocete cetacean species stranded at Tierra del Fuego, *Globicephala melaena* (Traill, 1809), *Hyperoodon planifrons* Flower, 1882 and *Cepahlorhynchus commersonii* (Lacepede, 1804). **Antarct. Sci.** 6(2):149-154.

Clingham, E., L. Henry, and A. Beard. 2013. Monitoring population size of St. Helena cetaceans. EMD Environmental Management Division. Accesed in June 2015 at http://www.sainthelena.gov.sh/wp-content/uploads/2012/08/EMD-Cetaceans-2013.pdf.

Dalebout, M.L., K.G. Russell, M.J. Little, and P. Ensor. 2004. Observations of live Gray's beaked whales (*Mesoplodon grayi*) in Mahurangi Harbour, North Island, New Zealand, with a summary of at-sea sightings. **J. Roy. Soc. New Zeal.** 34(4):347-356.

Dalla Rosa, L. and E.R. Secchi. 2007. Killer whale (*Orcinus orca*) interactions with the tuna and swordfish longline fishery off southern and south-eastern Brazil: a comparison with shark interactions. **J. Mar. Biol. Ass. U.K.** 87(1):135-140.

Darling, J.D. and R.S. Sousa-Lima. 2005. Songs indicate interaction between humpback whales (*Megaptera novaeangliae*) populations in the western and eastern South Atlantic Ocean. **Mar. Mamm. Sci.** 21(3):557-566.

Davis, R.W., G.S. Fargion, N. May, T.D. Leming, M. Baumgartner, W.E. Evans, L.J. Hansen, and K. Mullin. 1998. Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. **Mar. Mamm. Sci.** 14(3):490-507.

Davis, R.W., J.G. Ortega-Ortiz, C.A. Ribic, W.E. Evans, D.C. Biggs, P.H. Ressler, R.B. Cady, R.R Lebend, K.D. Mullin, and B. Würsig. 2002. Cetacean habitat in the northern oceanic Gulf of Mexico. **Deep-Sea Res. I** 49(1):21-142.

de Boer, M.N. 2010. Cetacean distribution and relative abundance in offshore Gabonese waters. **J. Mar. Biol. Assoc. U.K.** 90(8):1613-1621.

de Oliveira Santos, M.C., E. Zampirolli, A.F.V. Vicente, and F. Alvarenga. 2003. A Gervais' beaked whale (*Mesoplodon europaeus*) washed ashore in southeastern Brazil: extralimital record? **Aquat. Mamm.** 29(3):404-410.

de Oliveira Santos, M.C., S. Siciliano, A.F. de Castro Vicente, F.S. Alvarenga, É. Zampirolli, S.P. de Souza, and A. Maranho. 2010. Cetacean records along São Paulo state coast, southeastern Brazil. **Braz. J. Oceanog.** 58(2):123-142.

de Souza, S.P., S. Siciliano, S. Cuenca, and B. de Sanctis. 2005. A True's beaked whale (*Mesoplodon mirus*) on the coast of Brazil: adding a new beaked whale species of the western topical Atlantic and South America. **LAJAM** 4(2):129-136.

Deng, Z.D., B.L. Southall, T.J. Carlson, J. Xu, J.J. Martinez, M.A. Weiland, and J.M. Ingraham. 2014. 200-kHz commercial sonar systems generate lower frequency side lobes audible to some marine mammals. **PLoS ONE** 9(4):e95315. doi:10.1371/journal.pone.0095315.

DeRuiter, S.L., I.L. Boyd, D.E. Claridge, C.W. Clark, C. Gagnon, B.L. Southall, and P.L. Tyack. 2013a. Delphinid whistle production and call matching during playback of simulated military sonar. **Mar. Mamm. Sci.** 29(2):E46-E59.

DeRuiter, S.L., B.L. Southall, J. Calambokidis, W.M.X. Zimmer, D. Sadykova, E.A. Falcone, A.S. Friedlaender, J.E. Joseph, D. Moretti, G.S. Schorr, L. Thomas, and P.L. Tyack. 2013b. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. **Biol. Lett.** 9:20130223. doi:10.1098/rsbl.2013.0223.

Di Iorio, L. and C.W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. **Biol. Lett.** 6(1):51-54.

Diebold, J.B., M. Tolstoy, L. Doermann, S.L. Nooner, S.C. Webb, and T.J. Crone. 2010. R/V *Marcus G. Langseth* seismic source: modeling and calibration. **Geochem. Geophys. Geosyst.** 11(12):Q12012. doi:10.1029/2010GC003126. 20 p.

Dolar, M.L.L. 2009. Fraser's dolphin *Lagenodelphis hosei*. p. 469-471 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Donahue, M.A. and W.L. Perryman. 2009. Pygmy killer whale, *Feresa attenuata*. p. 938-939 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Dyndo, M., D.M. Wisniewska, L. Rojano-Doñate, and P.T. Madsen. 2015. Harbour porpoises react to low levels of high frequency vessel noise. **Sci. Rep.** 5:11083. doi:10.1038/srep11083.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. **Conserv. Biol.** 26(1):21-28.

Engel, M.H. and A.R. Martin. 2009. Feeding grounds of the western South Atlantic humpback whale population. 2009. **Mar. Mamm. Sci.** 25(4):964-969.

Engel, M.H., M.C.C. Marcondes, C.C.A. Martins, F.O. Luna, R.P. Lima, and A. Campos. 2004. Are seismic surveys responsible for cetacean strandings? An unusual mortality of adult humpback whales in Abrolhos Bank, northeastern coast of Brazil. Working Pap. SC/56/E28. Int. Whal. Comm., Cambridge, U.K. 8 p.

Engel, M.H., N.J.R. Fagundes, H.C. Rosenbaum, M.S. Leslie, P.H. Ott, R. Schmitt, E. Secchi, L. Dalla Rosa, and S.L. Bonatto. 2008. Mitochondrial DNA diversity of the Southwestern Atlantic humpback whale (*Megaptera novaeangliae*) breeding area off Brazil, and the potential connections to Antarctic feeding areas. **Conserv. Genet.** 9(5):1253-1262.

Evans, P.G.H. 1987. The natural history of whales and dolphins. Christopher Helm, Bromley, Kent, U.K. 343 p.

Evans, W.E. 1994. Common dolphin, white-bellied porpoise *Delphinus delphis* Linnaeus, 1758. p. 191-224 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

EVOTIS. 2015. Tracking southern right whales in Península Valdés, Argentina. Accessed on 1 June 2015 at http://www.evotis.org/southern-right-whale-tracking/.

Ferguson, M.C., J. Barlow, P. Fiedler, S.B. Reilly, and T. Gerrodette. 2006. Spatial models of delphinid (family Delphinidae) encounter rate and group size in the eastern tropical Pacific Ocean. **Ecol. Model.** 193(3-4):645-662.

Ferreira, J.M., de Oliveira, L.R., L. Wynen, M.N. Bester, C. Guinet, N. Moraes-Barros, F.M. Martins, M.M.C. Muelbert, I.B. Moreno, S. Siciliano, P.H. Ott, and J.S. Morgante. 2008. Muliple origins of vagrant Subantarctic fur seals: a long journey to the Brazilian coast detected by molecular markers. **Polar Biol.** 31(3):303-308.

Fertl, D., T.A. Jefferson, I.B. Moreno, A.N. Zerbini, and K.D. Mullin. 2003. Distribution of the Clymene dolphin *Stenella clymene*. **Mamm. Rev.** 33(3):253-271.

Findlay, K.P., P.B. Best, G.J.B. Ross, and V.G. Cockcroft. 1992. The distribution of small odontocete cetaceans off the coasts of South-Africa and Namibia. **S. Afr. J. Mar. Sci.** 12:237-270.

Finneran, J.J. 2012. Auditory effects of underwater noise in odontocetes. p. 197-202 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Finneran, J.J. 2015. Noise-induced hearing loss in marine mammals: a review of temporary threshold shift studies from 1996 to 2015. **J. Acoust. Soc. Am.** 138(3):1702-1726.

Finneran, J.J. and B.K. Branstetter. 2013. Effects of noise on sound perception in marine mammals. p. 273-308 *In*: H. Brumm (ed.), Animal communication and noise. Springer Berlin, Heidelberg, Germany. 453 p.

Finneran, J.J. and C.E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*) (L). **J. Acoust. Soc. Am.** 128(2):567-570.

Finneran, J.J. and C.E. Schlundt. 2011. Noise-induced temporary threshold shift in marine mammals. **J. Acoust. Soc. Am.** 129(4):2432. [supplemented by oral presentation at the ASA meeting, Seattle, WA, May 2011].

Finneran, J.J. and C.E. Schlundt. 2013. Effects of fatiguing tone frequency on temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 133(3):1819-1826.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. **J. Acoust. Soc. Am.** 108(1):417-431.

Finneran, J.J., C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. **J. Acoust. Soc. Am.** 111(6):2929-2940.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. **J. Acoust. Soc. Am.** 118(4):2696-2705.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and R.L. Dear. 2010a. Growth and recovery of temporary threshold shift (TTS) at 3 kHz in bottlenose dolphins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 127(5):3256-3266.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and R.L. Dear. 2010b. Temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) exposed to intermittent tones. **J. Acoust. Soc. Am.** 127(5):3267-3272.

Finneran, J.J., C.E. Schlundt, B.K. Branstetter, J.S. Trickey, V. Bowman, and K. Jenkins. 2015. Effects of multiple impulses from a seismic air gun on bottlenose dolphin hearing and behavior. **J. Acoust. Soc. Am.** 137(4):1634-1646.

Fisch, F. and D. Port. 2013. New stranding record of *Ziphius cavirostris* (Cuvier, 1823) (Cetacean: Ziphiidae) at Trindade Island, Brazil. **Rev. Elect. Biol. (REB)** ISSN 1983-7682 6(3):286-291.

Flores, P.A. de C. and A. Ximinez. 1997. Observations on the rough-toothed dolphin *Steno bredanensis* off Santa Catarina Island, southern Brazilian coast. **Biotemas** 10(1):71-79.

Ford, J.K.B. 2009. Killer whale *Orcinus orca*. p. 650-657 *In*: W.F Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Forney, K.A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. **Mar. Mamm. Sci.** 14(3):460-489.

Forney, K.A. and P.R. Wade. 2006. Worldwide distribution and abundance of killer whales. p. 145-162 *In*: J.A. Estes, D.P. DeMaster, D.F. Doak, T.M. Williams, and R.L. Brownell (eds.), Whales, whaling and ocean ecosystems. Univ. California Press, Oakland, CA. 418 p.

Gailey, G., B. Würsig, and T.L. McDonald. 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, northeast Sakhalin Island, Russia. **Environ. Monit. Assessm.** 134(1-3):75-91.

Gales, N.J., M.L. Dalebout, and J.L. Bannister. 2002. Genetic identification and biological observation of two free-swimming beaked whales: Hector's beaked whale (*Mesoplodon hectori*, Gray, 1871), and Gray's beaked whale (*Mesoplodon grayi*, Von Haast, 1876). **Mar. Mamm. Sci.** 18(2):544-555.

Gallardo, V.A., D. Arcos, M. Salamanca, and L. Pastene. 1983. On the occurrence of Bryde's whales (*Balaenoptera edeni*, Anderson, 1978) in an upwelling area off central Chile. **Rep. Int. Whal. Comm.** 33:481-487.

Gambell, R. 1985. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). p. 171-192 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 3: The Sirenians and baleen whales. Academic Press, London, U.K. 362 p.

Gannier, A. and J. Epinat. 2008. Cuvier's beaked whale distribution in the Mediterranean Sea: results from small boat surveys 1996–2007. **J. Mar. Biol. Assoc. U.K.** 88(6):1245-1251.

Garrigue, C., A. Aguayo, V.L.U. Amante-Helweg, C.S. Baker, S. Caballero, P. Clapham, R. Constantine, J. Denkinger, M. Donoghue, L. Flórez-González, J. Greaves, N. Hauser, C. Olavarría, C. Pairoa, H. Peckham, and M. Poole. 2002. Movements of humpback whales in Oceania, South Pacific. **J. Cetac. Res. Manage.** 4(3):255-260.

Gedamke, J. 2011. Ocean basin scale loss of whale communication space: potential impacts of a distant seismic survey. p. 105-106 *In*: Abstr. 19th Bienn. Conf. Biol. Mar. Mamm., 27 Nov.–2 Dec. 2011, Tampa, FL. 344 p.

Gedamke, J., N. Gales, and S. Frydman. 2011. Assessing risk of baleen whale hearing loss from seismic surveys: the effects of uncertainty and individual variation. **J. Acoust. Soc. Am.** 129(1):496-506.

Gervaise, C., N. Roy, Y. Simard, B. Kinda, and N. Menard. 2012. Shipping noise in whale habitat: characteristics, sources, budget, and impact on belugas in Saguenay-St. Lawrence Marine Park hub. **J. Acoust. Soc. Am.** 132(1):76-89.

Goldbogen, J.A., B.L. Southall, S.L. DeRuiter, J. Calambokidis, A.S. Friedlaender, E.L. Hazen, E. Falcone, G. Schorr, A. Douglas, D.J. Moretti, C. Kyburg, M.F. McKenna, and P.L. Tyack. 2013. Blue whales respond to simulated mid-frequency military sonar. **Proc. R. Soc. B.** 280:20130657. doi:10.1098/rspb.2013.0657.

Gong, Z., A.D. Jain, D. Tran, D.H. Yi, F. Wu, A. Zorn, P. Ratilal, and N.C. Makris. 2014. Ecosystem scale acoustic sensing reveals humpback whale behavior synchronous with herring spawning processes and re-evaluation finds no effect of sonar on humpback song occurrence in the Gulf of Maine in fall 2006. **PLoS ONE** 9(10):e104733. doi:10.1371/journal.pone.0104733.

Goodall, R.N.P. 2009. Hourglass dolphin *Lagenorhynchus cruciger*. p. 573-576 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Goodall, R.N.P., M.C. Marchesi, L.E. Pimper, N. Dellabianca, L.G. Benegas, M.A. Torres, and L. Riccialdelli. 2011. Southernmost records of bottlenose dolphins, *Tursiops truncatus*. **Polar Biol.** 34(7):1085-1090.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2004. A review of the effects of seismic surveys on marine mammals. **Mar. Technol. Soc. J.** 37(4):16-34.

Grandi, M.F., A.D. Buren, E.A. Crespo, N.A. García, G.M. Svendsen, and S.L. Dans. 2005. Record of a specimen of Shepherd's beaked whale (*Tasmacetus shepherdi*) from the coast of Santa Cruz, Argentina, with notes on age determination. **LAJAM** 4(2):97-100.

Gray, H. and K. Van Waerebeek. 2011. Postural instability and akinesia in a pantropical spotted dolphin, *Stenella attenuata*, in proximity to operating airguns of a geophysical seismic vessel. **J. Nature Conserv.** 19(6):363-367.

Guerra, M., A.M. Thode, S.B. Blackwell, and M. Macrander. 2011. Quantifying seismic survey reverberation off the Alaskan North Slope. **J. Acoust. Soc. Am.** 130(5):3046-3058.

Guerra, M., P.J. Dugan, D.W. Ponirakis, M. Popescu, Y. Shiu, and C.W. Clark. 2013. High-resolution analysis of seismic airgun impulses and their reverberant field as contributors to an acoustic environment. Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Hansen, L.J., K.D. Mullin, and C.L. Roden. 1994. Preliminary estimates of cetacean abundance in the northern Gulf of Mexico, and selected species in the U.S. Atlantic exclusive economic zone from vessel surveys. Miami Lab Contrib. No. MIA-93/94-58. Nat. Mar. Fish. Serv., Southeast Fish. Sci. Center, Miami, FL. 14 p.

Hastie, G.D., C. Donovan, T. Götz, and V.M. Janik. 2014. Behavioral responses of grey seals (*Halichoerus grypus*) to high frequency sonar. **Mar. Poll. Bull.** 79(1-2):205-210.

Hatch, L.T., C.W. Clark, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. **Conserv. Biol.** 26(6):983-994.

Heide-Jørgensen, M.P., R.G. Hansen, S. Fossette, N.J. Nielsen, M.V. Jensen, and P. Hegelund. 2013a. Monitoring abundance and hunting of narwhals in Melville Bay during seismic surveys. Preliminary report from the Greenland Institute of Natural Resources. 59 p. Accessed on 13 March 2015 at http://www.natur.gl/fileadmin/user_files/Dokumenter/PAFU/Monitoring_abundance_and_hunting_of_narwhals_in_Melville_Bay_GINR_Preliminary_report_endelig__2_.pdf.

Heide-Jørgensen, M.P., R.G. Hansen, K. Westdal, R.R. Reeves, and A. Mosbech. 2013b. Narwhals and seismic exploration: is seismic noise increasing the risk of ice entrapments? **Biol. Conserv.** 158:50-54.

Hermannsen, L., J. Tougaard, K. Beedholm, J. Nabe-Nielsen, and P.T. Madsen. 2014. High frequency components of ship noise in shallow water with a discussion of implications for harbor porpoises (*Phocoena phocoena*). **J. Acoust. Soc. Am.** 136(4):1640-1653.

Hermannsen, L., K. Beedholm, J. Tougaard, and P.T. Madsen. 2015. Characteristics and propagation of airgun pulses in shallow water with implications for effects on small marine mammals. **PLoS ONE** 10(7):e0133436. doi:10.1371/journal.pone.0133436.

Heyning, J.E. 1989. Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. p. 289-308 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego, CA. 444 p.

Heyning, J.E. and M.E. Dalheim. 1988. *Orcinus orca*. **Mammal. Spec.** 304:1-9.

Hindell, M.A. and W.F. Perrin. 2009. Elephant seals *Mirounga angustirostris* and *M. leonine*. p. 364-368 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Hofmeyr, G.J.G., M.N. Bester, and F.C. Jonker. 1997. Changes in population sizes and distribution of fur seals at Marion island. **Polar Biol.** 17(2):150-158.

Holt, M.M., D.P. Noren, R.C. Dunkin, and T.M. Williams. 2015. Vocal performance affects metabolic rate in dolphins: implications for animals communicating in noisy environments. **J. Exp. Biol.** 218(11):1647-1654. doi:10.1242/jeb.122424.

Horwood, J. 2009. Sei whale *Balaenoptera borealis*. p. 1001-1003 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Iñíguez, M., J.F. Masello, C. Gribaudo, D. Arcucci, F. Krohling, and J. Belgrano. 2010. On the occurrence of sei whales, *Balaenoptera borealis*, in the south-western Atlantic. **Mar. Biodiv. Rec** 3:e68. doi:10.1017/S1755267210000576.

IUCN (International Union for Conservation of Nature). 2015. The IUCN Red List of Threatened Species. Version 2015.2. Accessed in July 2015 at http://www.iucnredlist.org.

IWC (International Whaling Commission). 1981. Report of the subcommittee on other baleen whales. **Rep. Int. Whal. Comm.** 31:122-132.

IWC (International Whaling Commission). 2001. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. **J. Cetac. Res. Manage. Spec. Iss.** 2:1-60.

IWC (International Whaling Commission). 2007. Report of the standing working group on environmental concerns. Annex K to Report of the Scientific Committee. **J. Cetac. Res. Manage**. 9(Suppl.):227-260.

IWC (International Whaling Commission). 2014. Satellite tagging to help solve the puzzle of southern right whale die-off in Patagonia. Accessed on 12 May 2015 at https://iwc.int/satellite-tagging-to-help-understand-southern-righ.

IWC (International Whaling Commission). 2015. Whale population estimates. Accessed on 12 May 2015 at http://iwc.int/estimate.

Jackson, J.A., D.J. Steel, P. Beerli, B.C. Congdon, C. Olavarría, M.S. Leslie, C. Pomilla, H. Rosenbaum, and C.S. Baker. 2014. Global diversity and oceanic divergence of humpback whales (*Megaptera novaeangliae*). Proc. R. Soc. B 281:20133222. http://dx.doi.org/10.1098/rspb.2013.3222.

Jaquet, N. and H. Whitehead. 1996. Scale-dependent correlation of sperm whale distribution with environmental features and productivity in the South Pacific. **Mar. Ecol. Prog. Ser.** 135:1-9.

Jaquet, N. and D. Gendron. 2002. Distribution and relative abundance of sperm whales in relation to key environmental features, squid landings and the distribution of other cetacean species in the Gulf of California, Mexico. **Mar. Biol.** 141(3):591-601.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine mammals of the world: a comprehensive guide to their identification. Elsevier, London, U.K. 573 p.

Jensen, F.H., L. Bejder, M. Wahlberg, N. Aguilar Soto, M. Johnson, and P.T. Madsen. 2009. Vessel noise effects on delphinid communication. **Mar. Ecol. Prog. Ser.** 395:161-175.

Johnson, S.R., W.J. Richardson, S.B. Yazvenko, S.A. Blokhin, G. Gailey, M.R. Jenkerson, S.K. Meier, H.R. Melton, M.W. Newcomer, A.S. Perlov, S.A. Rutenko, B. Würsig, C.R. Martin, and D.E. Egging. 2007. A western gray whale mitigation and monitoring program for a 3-D seismic survey, Sakhalin Island, Russia. **Environ. Monit. Assess.** 134(1-3):1-19.

Kasamatsu, F. and G.G. Joyce. 1995. Current status of odontocetes in the Antarctic. **Antarct. Sci.** 7(4):365-379.

Kastak, D. and C. Reichmuth. 2007. Onset, growth, and recovery of in-air temporary threshold shift in a California sea lion (*Zalophus californianus*). **J. Acoust. Soc. Am.** 122(5):2916-2924.

Kastak, D., R.L. Schusterman, B.L. Southall, and C.J. Reichmuth. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinnipeds. **J. Acoust. Soc. Am.** 106(2):1142-1148.

Kastak, D., B.L. Southall, R.J. Schusterman, and C. Reichmuth Kastak. 2005. Underwater temporary threshold shift in pinnipeds: effects of noise level and duration. **J. Acoust. Soc. Am.** 118(5):3154-3163.

Kastak, D., J. Mulsow, A. Ghoul, and C. Reichmuth. 2008. Noise-induced permanent threshold shift in a harbor seal. **J. Acoust. Soc. Am.** 123(5):2986.

Kastelein, R., R. Gransier, L. Hoek, and J. Olthuis. 2012a. Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. **J. Acoust. Soc. Am.** 132(5):3525-3537.

Kastelein, R.A., R. Gransier, L. Hoek, A. Macleod, and J.M. Terhune. 2012b. Hearing threshold shifts and recovery in harbor seals (*Phoca vitulina*) after octave-band noise exposure at 4 kHz. **J. Acoust. Soc. Am.** 132(4):2745-2761.

Kastelein, R.A., N. Steen, R. Gransier, and C.A.F. de Jong. 2013a. Brief behavioral response threshold level of a harbor porpoise (*Phocoean phocoena*) to an impulsive sound. **Aquat. Mamm.** 39(4):315-323.

Kastelein, R.A., R. Gransier, and L. Hoek, and M. Rambags. 2013b. Hearing frequency thresholds of a harbour porpoise (*Phocoena phocoena*) temporarily affected by a continuous 1.5-kHz tone. **J. Acoust. Soc. Am.** 134(3):2286-2292.

Kastelein, R., R. Gransier, and L. Hoek. 2013c. Comparative temporary threshold shifts in a harbour porpoise and harbour seal, and severe shift in a seal (L). **J. Acoust. Soc. Am.** 134(1):13-16.

Kastelein, R.A., L. Hoek, R. Gransier, M. Rambags, and N. Clayes. 2014. Effect of level, duration, and inter-pulse interval of 1–2 kHz sonar signal exposures on harbor porpoise hearing. **J. Acoust. Soc. Am.** 136:412-422.

Kastelein, R.A., R. Gransier, J. Schop, and L. Hoek. 2015a. Effects of exposure to intermittent and continuous 6–7 kHz sonar sweeps on harbor porpoise (*Phocoena phocoena*) hearing. **J. Acoust. Soc. Am.** 137(4):1623-1633.

Kastelein, R.A., R. Gransier, M.A.T. Marijt, and L Hoek. 2015b. Hearing frequency thresholds of harbor porpoises (*Phocoena phocoena*) temporarily affected by played back offshore pile driving sounds. **J. Acoust. Soc. Am.** 137(2):556-564.

Kasuya, T. 1986. Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. **Sci. Rep. Whales Res. Inst.** 37:61-83.

Kasuya, T. 2009. Giant beaked whales *Berardius bairdii* and *B. arnuxii*. p. 498-500 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Kato, H. and W.F. Perrin. 2009. Bryde's whales *Balaenoptera edeni/brydei*. p. 158-163 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Kemper, C.M. 2002. Distribution of the pygmy right whale, *Caperea marginata*, in the Australasian region. **Mar. Mamm. Sci.** 18(1):99-111.

Kemper, C.M. 2009. Pygmy right whale *Caperea marginata*. p. 939-941 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Kenney, R.D. 2009. Right whales *Eubalaena glacialis*, *E. japonica*, and *E. australis*. p. 962-972 *In*: W.F. Perrin, B. Würsig, and J. G. M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Ketten, D.R. 2012. Marine mammal auditory system noise impacts: evidence and incidence. p. 207-212 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Ketten, D.R., J. O'Malley, P.W.B. Moore, S. Ridgway, and C. Merigo. 2001. Aging, injury, disease, and noise in marine mammal ears. **J. Acoust. Soc. Am.** 110(5, Pt. 2):2721 (Abstract).

Klinck, H., S.L. Nieukirk, D.K. Mellinger, K. Klinck, H. Matsumoto, and R.P. Dziak. 2012. Seasonal presence of cetaceans and ambient noise levels in polar waters of the North Atlantic. **J. Acoust. Soc. Am.** 132(3):EL176-EL181.

Krieger, K.J. and B.L. Wing. 1984. Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, summer 1983. NOAA Tech. Memo. NMFS F/NWC-66. U.S. Natl. Mar. Fish. Serv., Auke Bay, AK. 60 p. NTIS PB85-183887.

Krieger, K.J. and B.L. Wing. 1986. Hydroacoustic monitoring of prey to determine humpback whale movements. NOAA Tech. Memo. NMFS F/NWC-98. U.S. Natl. Mar. Fish. Serv., Auke Bay, AK. 63 p. NTIS PB86-204054.

Laporta, P., R. Praderi, V. Little, and A. Le Bas. 2005. An Andrew's beaked whale *Mesoplodon bowdoini* (Cetacean, Ziphiidae) stranded on the Atlantic coast of Uruguay. **LAJAM** 4(2):101-111.

Laws, R. 2012. Cetacean hearing-damage zones around a seismic source. p. 473-476 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Le Prell, C.G. 2012. Noise-induced hearing loss: from animal models to human trials. p. 191-195 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Lewis, M., C. Campagna, M.R. Marin, and T. Fernandez. 2006a. Southern elephant seals north of the Antarctic Polar Front. **Antarct. Sci.** 18(2):213-221.

Lewis, M.N., C. Campagna, and M.R. Marin. 2006b. Distribution ashore and breeding places of southern elephant seals in South America. *In:* Distribution of elephant seals. Mirtha Lewis, Centro Nacional Patagónico, Puerto Madryn, Argentina. Retrieved from http://www.iobis.org.

Liberman, C. 2013. New perspectives on noise damage. Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Lipsky, J.D. 2009. Right whale dolphins *Lissodelphis borealis, L. peronii*. p. 958-962 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Lucke, K., U. Siebert, P.A. Lepper, and M.A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. **J. Acoust. Soc. Am.** 125(6):4060-4070.

Luís, A.R., M.N. Couchinho, and M.E. Dos Santos. 2014. Changes in the acoustic behavior of resident bottlenose dolphins near operating vessels. 2014. **Mar. Mamm. Sci.** 30(4):1417-1426.

Lurton, X. 2015. Modelling of the sound field radiated by multibeam echosounders for acoustical impact assessment. **Appl. Acoust.** 101:201-216.

Lusseau, D. and L. Bejder. 2007. The long-term consequences of short-term responses to disturbance experience from whalewatching impact assessment. **Int. J. Comp. Psych.** 20(2-3):228-236.

MacGillivray, A.O., R. Racca, and Z. Li. 2014. Marine mammal audibility of selected shallow-water survey sources. **J. Acoust. Soc. Am.** 135(1):EL35-EL40.

MacLeod, C.D. and E. Bennett. 2007. Pan-tropical spotted dolphins (*Stenella attenuata*) and other cetaceans around St Helena in the tropical south-eastern Atlantic. **J. Mar. Biol. Ass. U.K.** 87(1):339-344.

MacLeod, C.D. and G. Mitchell. 2006. Key areas for beaked whales worldwide. **J. Cetac. Res. Manage.** 7(3):309-322.

MacLeod, C.D., N. Hauser, and H. Peckham. 2004. Diversity, relative density and structure of the cetacean community in summer months east of Great Abaco, Bahamas. **J. Mar. Biol. Assoc. U.K.** 84(2):469-474.

MacLeod, C.D., W.F. Perrin, R. Pitman, J. Barlow, L.T. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K.D. Mullin, D. Palka, and G.T. Waring. 2006. Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). **J. Cetac. Res. Manage.** 7(3):271-286.

Malme, C.I. and P.R. Miles. 1985. Behavioral responses of marine mammals (gray whales) to seismic discharges. p. 253-280 *In*: G.D. Greene, F.R. Engelhard, and R.J. Paterson (eds.), Proc. Workshop on Effects of Explosives Use in the Marine Environment, Jan. 1985, Halifax, NS. Tech. Rep. 5. Can. Oil & Gas Lands Admin., Environ. Prot. Br., Ottawa, Ont. 398 p.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for MMS, Alaska OCS Region, Anchorage, AK. NTIS PB86-218377.

Malme, C.I., P.R. Miles, P. Tyack, C.W. Clark, and J.E. Bird. 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior. BBN Rep. 5851. OCS Study MMS 85-0019. Rep. from BBN Labs Inc., Cambridge, MA, for MMS, Anchorage, AK. NTIS PB86-218385.

Malme, C.I., B. Würsig, J.E. Bird, and P. Tyack. 1986. Behavioral responses of gray whales to industrial noise: feeding observations and predictive modeling. BBN Rep. 6265. OCS Study MMS 88-0048. Outer Contin. Shelf Environ. Assess. Progr., Final Rep. Princ. Invest., NOAA, Anchorage, AK. 56(1988):393-600. NTIS PB88-249008.

Malme, C.I., B. Würsig, B., J.E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. p. 55-73 *In*: W.M. Sackinger, M.O. Jeffries, J.L. Imm, and S.D. Treacy (eds.), Port and Ocean Engineering Under Arctic Conditions Vol. II. Symposium on noise and marine mammals. Univ. Alaska Fairbanks, Fairbanks, AK. 111 p.

Martins, C.C.A., M.E. Morete, M.H. Engel, A.C. Freitas, E.R. Secchi, and P.G. Kinas. 2001. Aspects of habitat use patterns of humpback whales in the Abrolhos Bank, Brazil, breeding ground. **Mem. Queensl. Mus.** 47(2):563-570.

Mate, B.R., P.B. Best, B.A. Lagerquist, and M.H. Winsor. 2011. Coastal, offshore, and migratory movements of South African right whales revealed by satellite telemetry. **Mar. Mamm. Sci.** 27(3):455-476.

Maughan, B. 2003. United Kingdom Royal Navy cetacean sighting. Retrieved from http://www.iobis.org.

McAlpine, D.F. 2009. Pygmy and dwarf sperm whales *Kogia breviceps* and *K. sima*. p. 936-938 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

McCauley, R.D., M.-N. Jenner, C. Jenner, K.A. McCabe, and J. Murdoch. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: preliminary results of observations about a working seismic vessel and experimental exposures. **APPEA J.** 38:692-707.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: analysis of airgun signals; and effects of air gun exposure on humpback whales, sea turtles, fishes and squid. Rep. from Centre for Marine Science and Technology, Curtin Univ., Perth, Western Australia, for Australian Petrol. Produc. & Explor. Assoc., Sydney, NSW. 188 p.

McConnell, B.J. and M.A. Fedak. 1996. Movements of southern elephant seals. **Can. J. Zool.** 74(8):1485-1496.

McDonald, T.L., W.J. Richardson, K.H. Kim, and S.B. Blackwell. 2010. Distribution of calling bowhead whales exposed to underwater sounds from Northstar and distant seismic surveys, 2009. p. 6-1 to 6-38 *In*: W.J. Richardson (ed.), Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar oil development, Alaskan Beaufort Sea: comprehensive report for 2005–2009. LGL Rep. P1133-6. Rep. from LGL Alaska Res. Assoc. Inc., Anchorage, AK, Greeneridge Sciences Inc., Santa Barbara, CA, WEST Inc., Cheyenne, WY, and Applied Sociocult. Res., Anchorage, AK, for BP Explor. (Alaska) Inc., Anchorage, AK. 265 p.

McDonald, T.L., W.J. Richardson, K.H. Kim, S.B. Blackwell, and B. Streever. 2011. Distribution of calling bowhead whales exposed to multiple anthropogenic sound sources and comments on analytical methods. p. 199 *In*: Abstr. 19th Bienn. Conf. Biol. Mar. Mamm., 27 Nov.–2 Dec. 2011, Tampa, FL. 344 p.

Mead, J.G. 1989a. Shepherd's beaked whale *Tasmacetus shepherdi* Oliver, 1937. p. 309-320 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego, CA. 444 p.

Mead, J.G. 1989b. Beaked whales of the genus *Mesoplodon*. p. 349-430 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego, CA. 442 p.

Mead, J.G. 2009. Shepherd's beaked whale *Tasmacetus shepherdi*. p. 1011-1014 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Melcón, M.L., A.J. Cummins, S.M. Kerosky, L.K. Roche, S.M. Wiggins, and J.A. Hildebrand. 2012. Blue whales response to anthropogenic noise. **PLoS ONE** 7(2):e32681. doi:10.1371/journal.pone.0032681.

Mikhalev, Y.A., M.V. Ivashin, V.P. Savusin, and F.E. Zelenaya. 1981. The distribution and biology of killer whales in the Southern Hemisphere. **Rep. Int. Whal. Comm.** 31:551-566.

Miller, G.W., R.E. Elliott, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. p. 5-1 to 5-109 *In:* W.J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 390 p.

Miller, G.W., V.D. Moulton, R.A. Davis, M. Holst, P. Millman, A. MacGillivray, and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001–2002. p. 511-542 *In:* S.L. Armsworthy, P.J. Cranford, and K. Lee (eds.), Offshore oil and gas environmental effects monitoring/approaches and technologies. Battelle Press, Columbus, OH. 631 p.

Miller, P.J.O., M.P. Johnson, P.T. Madsen, N. Biassoni, M. Quero, and P.L. Tyack. 2009. Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico. **Deep-Sea Res. I** 56(7):1168-1181.

Miller, P.J.O., P.H. Kvadsheim, F.P.A. Lam, P.J. Wensveen, R. Antunes, A.C. Alves, F. Visser, L. Kleivane, P.L. Tyack, and L.D. Sivle. 2012. The severity of behavioral changes observed during experimental exposures of killer (*Orcinus orca*), long-finned pilot (*Globicephala melas*), and sperm whales (*Physeter macrocephalus*) to naval sonar. **Aquat. Mamm.** 38(4):362-401.

Miyazaki, N. and W.F. Perrin. 1994. Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828). p. 1-21 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Moore, M.J., S.D. Berrow, B.A. Jensen, P. Carr, R. Sears, V.J. Rowntree, R. Payne, and P.K. Hamilton. 1999. Relative abundance of large whales around South Georgia (1979–1998). **Mar. Mamm. Sci.** 15(4):1287-1302.

Moreno, I.B., A.N. Zerbini, D. Danilewicz, M.C. deo Oliveira Santos, P.C. Simões-Lopes, J. Lailson-Brito Jr., and A.F. Azevedo. 2005. Distribution and habitat characteristics of dolphins of the genus *Stenella* (Cetacea: Delphinidae) in the southwest Atlantic Ocean. **Mar. Ecol. Prog. Ser.** 300:229-240.

Moulton, V.D. and M. Holst. 2010. Effects of seismic survey sound on cetaceans in the Northwest Atlantic. Environ. Stud. Res. Funds Rep. 182. St. John's, Nfld. 28 p. Accessed in March 2015 at http://www.esrfunds.org/pdf/182.pdf.

Muñoz-Hincapié, M.F., D.M. Mora-Pinto, D.M. Palacios, E.R. Secchi, and A.A. Mignucci-Giannoni. 1998. First osteological record of the dwarf sperm whale in Colombia, with notes on the zoogeography of *Kogia* in South America. **Revista Acad. Colomb. Cien.** 22(84):433-444.

Nachtigall, P.E. and A.Y. Supin. 2013. A false killer whale reduces its hearing sensitivity when a loud sound is preceded by a warning. **J. Exp. Biol.** 216(16):3062-3070.

Nachtigall, P.E. and A.Y. Supin. 2014. Conditioned hearing sensitivity reduction in the bottlenose dolphin (*Tursiops truncatus*). **J. Exp. Biol.** 217(15):2806-2813.

Nachtigall, P.E. and A.Y. Supin. 2015. Conditioned frequency-dependent hearing sensitivity reduction in the bottlenose dolphin (*Tursiops truncatus*). **J. Exp. Biol.** 218(7):999-1005.

New, L.F., J. Harwood, L. Thomas, C. Donovan, J.S. Clark, G. Hastie, P.M. Thompson, B. Cheney, L. Scott-Hayward, and D. Lusseau. 2013. Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. **Function. Ecol.** 27(2):314-322.

Nieukirk, S.L., D.K. Mellinger, S.E. Moore, K. Klinck, R.P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999–2009. **J. Acoust. Soc. Am.** 131(2):1102-1112.

NMFS (National Marine Fisheries Service). 2000. Small takes of marine mammals incidental to specified activities: marine seismic-reflection data collection in southern California/Notice of receipt of application. **Fed. Regist.** 65(60, 28 Mar.):16374-16379.

NMFS (National Marine Fisheries Service). 2001. Small takes of marine mammals incidental to specified activities: oil and gas exploration drilling activities in the Beaufort Sea/Notice of issuance of an incidental harassment authorization. **Fed. Regist.** 66(26, 7 Feb.):9291-9298.

NMFS (National Marine Fisheries Service). 2013a. Takes of marine mammals incidental to specified activities; marine geophysical survey on the Mid-Atlantic Ridge in the Atlantic Ocean, April 2013, through June 2013. Notice; issuance of an incidental harassment authorization. **Fed. Regist.** 78(72, 15 Apr.):22239-22251.

NMFS (National Marine Fisheries Service). 2013b. Takes of marine mammals incidental to specified activities; marine geophysical survey in the northeast Atlantic Ocean, June to July 2013. Notice; issuance of an incidental harassment authorization. **Fed. Regist.** 78(109, 6 Jun.):34069-34083.

NMFS (National Marine Fisheries Service). 2013c. Effects of oil and gas activities in the Arctic Ocean: supplemental draft environmental impact statement. U.S. Depart. Commerce, NOAA, NMFS, Office of Protected Resources. Accessed in June 2015 at http://www.nmfs.noaa.gov/pr/permits/eis/arctic_sdeis.pdf.

NMFS (National Marine Fisheries Service). 2015a. Endangered and threatened marine species under NMFS' jurisdiction. Accessed on 12 May 2015 at http://www.nmfs.noaa.gov/pr/species/esa/.

NMFS (National Marine Fisheries Service). 2015b. Endangered and threatened species; identification of 14 distinct population segments of the humpback whale (*Megaptera novaeangliae*) and proposed revision of species-wide listing; Proposed Rule. **Fed. Regist.** 80(76, 21 Apr.):22304-22356.

NMFS (National Marine Fisheries Service). 2015c. Takes of marine mammals incidental to specified activities; marine geophysical survey in the eastern Mediterranean Sea, November to December, 2015; proposed incidental harassment authorization. **Fed. Regist.** 80(172, 4 Sept.):53624-53689.

NOAA (National Oceanic and Atmospheric Administration). 2015. Draft guidance for assessing the effects of anthropogenic sound on marine mammals/Acoustic threshold levels for onset of permanent and temporary threshold shifts. Rev. vers. for Second Public Comment Period, 23 Jul. 2015. 180 p. Accessed in October 2015 at http://www.nmfs.noaa.gov/pr/acoustics/draft%20acoustic%20guidance%20July%202015.pdf.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. **Mammal Rev.** 37(2):81-115.

Nowacek, D.P., K. Bröker, G. Donovan, G. Gailey, R. Racca, R.R. Reeves, A.I. Vedenev, D.W. Weller, and B.L. Southall. 2013. Responsible practices for minimizing and monitoring environmental impacts of marine seismic surveys with an emphasis on marine mammals. **Aquat. Mamm.** 39(4):356-377.

Nowacek, D.P., C.W. Clark, P.Mann, P.J.O. Miller, H.C. Rosenbaum, J.S. Golden, M. Jasny, J. Kraska, and B.L. Southall. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. **Front. Ecol. Environ.** 13(7):378-386. doi:10.1890/130286.

NRC (National Research Council). 2005. Marine mammal populations and ocean noise/Determining when noise causes biologically significant effects. U.S. Nat. Res. Counc., Ocean Studies Board, Committee on characterizing biologically significant marine mammal behavior (Wartzok, D.W., J. Altmann, W. Au, K. Ralls, A. Starfield, and P.L. Tyack). Nat. Acad. Press, Washington, DC. 126 p.

NSF (National Science Foundation). 2012. Record of Decision for marine seismic research funded by the National Science Foundation. June 2012. 41 p. Accessed in March 2015 at http://www.nsf.gov/geo/oce/envcomp/rod-marine-seismic-research-june2012.pdf.

NSF and USGS (National Science Foundation and U.S. Geological Survey). 2011. Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Accessed in March 2015 at http://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis-with-appendices.pdf.

OBIS (Ocean Biogeographic Information System). 2015. Global biodiversity indices from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. Accessed in February 2015 at http://www.iobis.org.

Odell, D.K. and K.M. McClune. 1999. False killer whale *Pseudorca crassidens* (Owen, 1846). p. 213-243 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 6: The second book of dolphins and the porpoises. Academic Press, San Diego, CA. 486 p.

Oliveira, A., C.K.M. Kolesnikovas, P.P. Serafini, L.M.P. Moreira, M. Pontalti, P.C. Simoes-Lopes, and A.S. Barreto. 2011. Occurrence of pinnipeds in Santa Catarina between 2000 and 2010. **LAJAM** 9(2):145-149.

Olson, P.A. 2009. Pilot whales—*Globicephala melas* and *G. macrorhynchus*. p. 847-852 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Otley, H. 2012. The composition of the cetacean community in the Falkland (Malvinas) Islands, southwest South Atlantic Ocean. **Rev. Biol. Mar. Oceanog.** 47(3):537-551.

Otley, H., J. Smith, and M.L. Dalebout. 2012. Beaked whale strandings on the Falkland Islands and South Georgia, South Atlantic Ocean, between 1866 and 2008. **J. Mar. Biol. Assoc. U.K.** 92(8):1851-1864.

Papale, E., M. Gamba, M. Perez-Gil, V.M. Martin, and C. Giacoma. 2015. Dolphins adjust species-specific frequency parameters to compensate for increasing background noise. **PLoS ONE** 10(4):e0121711. doi:10.1371/journal.pone.0121711.

Parks, S.E., M. Johnson, D. Nowacek, and P.L. Tyack. 2011. Individual right whales call louder in increased environmental noise. **Biol. Lett.** 7(1):33-35.

Parks, S.E., M.P. Johnson, D.P. Nowacek, and P.L. Tyack. 2012. Changes in vocal behaviour of North Atlantic right whales in increased noise. p. 317-320 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Passadore, C., A. Domingo, M. Szephegyi, and E.R. Secchi. 2014. Influence of environmental and longline fishing operational variables on the presence of killer whales (*Orcinus orca*) in south-western Atlantic. **J. Mar. Biol. Assoc.** U.K. 94(6):1267-1276.

Passadore, C., A. Domingo, and E.R. Secchi. 2015. Depradation by killer whale (*Orcinus orca*) and false killer whale (*Pseudorca crassidens*) on the catch of the Uruguayan pelagic longline fishery in southwestern Atlantic Ocean. **ICES J. Mar. Sci.** 72(5):1653-1666. doi:10.1093/icesjms/fsu251.

Patenaude, N.J., V.A. Portway, C.M. Schaeff, J.L. Bannister, P.B. Best, R.S. Payne, V.J. Rowntree, M. Rivarola, and C.S. Baker. 2007. Mitochondrial DNA diversity and population structure among southern right whales (*Eubalaena australis*). **J. Heredity** 98(2):147-157.

Payne, R. 1978. Behavior and vocalizations of humpback whales (*Megaptera* sp.). *In*: K.S Norris and R.R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. MCC-77/03. Rep. from Sea Life Inc., Makapuu Pt., HI, for U.S. Mar. Mamm. Comm., Washington, DC.

Perrin, W.F. 2009a. Spinner dolphin *Stenella longirostris*. p. 1100-1103 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Perrin, W.F. 2009b. Pantropical spotted dolphin *Stenella attenuata*. p. 819-821 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Perrin, W.F. 2009c. Common dolphins *Delphinus delphis* and *D. capensis*. p. 255-259 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Perrin, W.F. and R.L. Brownell, J. 2009. Minke whales. p. 733-735 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Perrin, W.F. and J.W. Gilpatrick, Jr. 1994. Spinner dolphin. p. 99-128 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Perrin, W.F., C.E. Wilson, and F.I. Archer II. 1994. Striped dolphin *Stenella coeruleoalba* (Meyen, 1833). p. 129-159 *In*: S. H. Ridgway and R. J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Perryman, W.L. 2009. Melon-headed whale *Peponocephala electra*. p. 719-721 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Pierson, M.O., J.P. Wagner, V. Langford, P. Birnie, and M.L. Tasker. 1998. Protection from, and mitigation of, the potential effects of seismic exploration on marine mammals. Chapter 7 *In*: M.L. Tasker and C. Weir (eds.), Proc. Seismic Mar. Mamm. Worksh., London, U.K., 23–25 June 1998.

Pinedo, M.C., A.S. Barreto, M.P. Lammardo, A.L.V. Andrade, and L. Geracitano. 2002a. Northernmost records of the spectacled porpoise, Layard's beaked whale, Commerson's dolphin, and Peale's dolphin in the southwestern Atlantic Ocean. **Aquat. Mamm.** 28(1):32-37.

Pinedo, M.C., T. Polacheck, A.S. Barreto, and M.P. Lammardo. 2002b. A note on vessel of opportunity sighting surveys for cetaceans in the shelf edge region off the southern coast of Brazil. **J. Cetac. Res. Manage.** 4(3):323-329.

Pirotta, E., R. Milor, N. Quick, D. Moretti, N. Di Marzio, P. Tyack, I. Boyd, and G. Hastie. 2012. Vessel noise affects beaked whale behavior: results of a dedicated acoustic response study. **PLoS ONE** 7(8):e42535. doi:10.1371/journal.pone.0042535.

Pirotta, E., K.L. Brookdes, I.M. Graham, and P.M. Thompson. 2014. Variation in harbour porpoise activity in response to seismic survey noise. **Biol. Lett.** 10:20131090. doi:10.1098/rsbl.2013.1090.

Pirotta, E., N.D. Merchant, P.M. Thompson, T.R. Barton, and D. Lusseau. 2015. Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity. **Biol. Conserv.** 181:82-98.

Pitman, R. 2009. Mesoplodon whales (*Mesoplodon* spp.). p. 721-726. *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Pitman, R.L., A.L. Van Helden, P.B. Best, and A. Pym. 2006. Shepherd's beaked whale (*Tasmacetus shepherdi*): information on appearance and biology based on strandings and at-sea observations. **Mar. Mamm. Sci.** 22(3):744-755.

Pomilla, C. and H.C. Rosenbaum. 2005. Against the current: an inter-oceanic whale migration event. **Biol. Lett.** 1(4):476-479.

Popov, V.V., A.Y. Supin, D. Wang, K. Wang, L. Dong, and S. Wang. 2011. Noise-induced temporary threshold shift and recovery in Yangtze finless porpoises *Neophocaena phocaenoides asiaeorientalis*. **J. Acoust. Soc. Am.** 130(1):574-584.

Popov, V.V., A.Y. Supin, V.V. Rozhnov, D.I. Nechaev, E.V. Sysuyeva, V.O. Klishin, M.G. Pletenko, and M.B. Tarakanov. 2013a. Hearing threshold shifts and recovery after noise exposure in beluga whales, *Delphinapterus leucas*. **J. Exper. Biol.** 216:1587-1596.

Popov, V., A. Supin, D. Nechaev, and E.V. Sysueva. 2013b. Temporary threshold shifts in naïve and experienced belugas: learning to dampen effects of fatiguing sounds? Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Popov, V.V., D.I. Nechaev, E.V. Sysueva, V.V. Rozhnov, and A.Y. Supin. 2015. Spectrum pattern resolution after noise exposure in a beluga whale, *Delphinapterus leucas*: evoked potential study. **J. Acoust. Soc. Am.** 138(1):377-388.

Reisinger, R.R. and M.N. Bester. 2010. Long distance breeding dispersal of a southern elephant seal. **Polar Biol.** 33(9):1289-1291.

Reyes, L.M. 2006. Cetacean distribution in the South Atlantic and South Pacific Ocean. Centro Nacional Patagónico (CENPAT), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina. Retrieved from http://www.iobis.org.

Rice, A.N., J.T. Tielens, B.J. Estabrook, C.A. Muirhead, A. Rahaman, M. Guerra, and C.W. Clark. 2014. Variation of ocean acoustic environments along the western North Atlantic coast: a case study in context of the right whale migration route. **Ecol. Inform.** 21:89-99.

Rice, D.W. 1998. Marine mammals of the world: systematics and distribution. Spec. Publ. 4. Society for Marine Mammalogy, Allen Press, Lawrence, KS. 231 p.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, CA. 576 p.

Richardson, W.J., G.W. Miller, and C.R. Greene, Jr. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. **J. Acoust. Soc. Am.** 106(4, Pt. 2):2281 (Abstract).

Risch, D., P.J. Corkeron, W.T. Ellison, and S.M. Van Parijs. 2012. Changes in humpback whale song occurrence in response to an acoustic source 200 km away. **PLoS One** 7:e29741. doi:10.1371/journal.pone.0029741.

Risch, D., P.J. Corkeron, W.T. Ellison, and S.M. Van Parijs. 2014. Formal comment to Gong et al.: Ecosystem scale acoustic sensing reveals humpback whale behavior synchronous with herring spawning processes and re-evaluation finds no effect of sonar on humpback song occurrence in the Gulf of Maine in fall 2006. **PLoS One** 9(10):e109225. doi:10.1371/journal.pone.0109225.

Robertson, F.C., W.R. Koski, T.A. Thomas, W.J. Richardson, B. Würsig, and A.W. Trites. 2013. Seismic operations have variable effects on dive-cycle behavior of bowhead whales in the Beaufort Sea. **Endang. Species Res.** 21(2):143-160.

Rolland, R.M., S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Water, and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. **Proc. R. Soc. B** 279(1737):2363-2368.

Rose, B. and A.I.L. Payne. 1991. Occurrence and behavior of the southern right whale dolphin *Lissodelphis peronii* off Namibia. **Mar. Mamm. Sci.** 7(1):25-34.

Rosenbaum, H.C., S.M. Maxwell, F. Kershaw, and B. Mate. 2014. Long-range movement of humpback whales and their overlap with anthropogenic actvity in the South Atlantic Ocean. **Conserv. Biol.** 28(2):604-615.

Rosenbaum, H.C., C. Pomilla, M. Mendez, M.S. Leslie, P.B. Best, K.P. Findlay, G. Minton, P.J. Ersts, T. Collins, M.H. Engel, S.L. Bonatto, D.P.G.H. Kotze, M. Meÿer, J. Barendse, M. Thornton, Y. Razafindrakoto, S. Ngouessono, M. Vely, and J. Kiszka. 2009. Population structure of humpback whales from their breeding grounds in the South Atlantic and Indian oceans. **PLoS ONE** 4(10):e7318. doi:10.1371/ journal.pone.0007318.

Rowntree, V.J., R.S. Payne, and D.M. Schell. 2001. Changing patterns of habitat use by southern right whales (*Eubalaena australis*) on their nursery ground at Península Valdés, Argentina, and in their long-range movements. **J. Cetac. Res. Manage. (Spec. Iss.)** 2:133-143.

Rowntree, V.J., M.M. Uhart, M. Sironi, A. Chirife, M. Di Martino, L. La Sala, L. Musmeci, N. Mohamed, J. Andrejuk, D. McAloose, J.E. Sala, A. Carribero, H. Rally, M. Franco, F.R. Adler, R.L. Brownell Jr., J. Seger, and T. Rowles. 2013. Unexplained recurring high mortality of southern right whale *Eubalaena australis* calves at Península Valdés, Argentina. **Mar. Ecol. Prog. Ser.** 493:275-289.

RPS. 2014. Draft protected species mitigation and monitoring report: U.S. Geological Survey 2-D seismic reflection scientific research survey program: mapping the U.S. Atlantic seaboard extended continental margin and investigating tsunami hazards, in the northwest Atlantic Ocean, Phase 1, 20 August 2014–13 September 2014, R/V *Marcus G. Langseth*. Rep. from RPS, Houston, TX, for Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY.

RPS. 2015. Protected species mitigation and monitoring report: East North American Margin (ENAM) 2-D seismic survey in the Atlantic Ocean off the coast of Cape Hatteras, North Carolina, 16 September–18 October 2014, R/V *Marcus G. Langseth*. Rep. from RPS, Houston, TX, for Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY.

Rudolph, P. and C. Smeenk. 2009. Indo-West Pacific marine mammals. p. 608-616 *In*: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Sairanen, E.E. 2014. Weather and ship induced sounds and the effect of shipping on harbor porpoise (*Phocoena phocoena*) activity. M.Sc. Thesis, University of Helsinki. Accessed in September 2015 at https://helda.helsinki.fi/bitstream/handle/10138/153043/Gradu_SairanenEeva(1).pdf?sequence=1.

Salden, D.R. 1993. Effects of research boat approaches on humpback whale behavior off Maui, Hawaii, 1989−1993. p. 94 *In*: Abstr. 10th Bienn. Conf. Biol. Mar. Mamm., Nov. 1993, Galveston, TX. 130 p.

Samaii, T., P.B. Best, and M.J. Gibbons. The taxonomic status of common dolphins *Delphinus* spp. in South African waters. **Afr. J. Mar. Sci.** 27(2):449-458.

Sears, R. and W.F. Perrin. 2009. Blue whale *Balaenoptera musculus*. p. 120-124 *In*: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Sekiguchi, K., N.T.W. Klages, and P.B. Best. 1995. Stomach contents of a southern bottlenose whale, *Hyperoodon planifrons*, stranded at Heard Island. **Mar. Mamm. Sci.** 11(4):575-584.

Sergeant, D.E. 1977. Stocks of fin whales *Balaenoptera physalus* L. in the North Atlantic Ocean. **Rep. Int. Whal. Comm.** 27:460-473.

Shaughnessy, P.D. and G.J.B. Ross. 1980. Records of the subantarctic fur seal (*Arctocephalus tropicalis*) from South Africa with notes on its biology and some observations of captive animals. **Ann. S. Afr. Mus.** 82(1-7):71-89. Accessed in June 2015 at http://www.biodiversitylibrary.org/item/126521#page/8/mode/1up.

Shirshov Institute. n.d. The census of marine life project: South Atlantic MAR ECO. Cruise #1_2009 R/V *Akademik Ioffe*, 25 October–29 November 2009. Academy of Sciences, Shirshov Institute, Russia. 10 p. Accessed in June 2015 at http://www.mar-eco.no/sci/__data/page/992/SA_MAR-ECO_Cruise_1-2009_Summary_Report.pdf.

Siciliano, S., M.C.O. Santos, A.F.C. Vicente, F.S. Alvarenga, E. Zampirolli, J.L Brito Jr., A.F Azevedo, and J.L.A. Pizzorno. 2004. Strandings and feeding records of Bryde's whales (*Balaenoptera edeni*) in southeastern Brazil. **J. Mar. Biol. Assoc. UK** 84(4):857-859.

Siciliano, S., J.F. de Moura, H.R. Filgueiras, P.P. Rodrigues, and N. de Oliveira Leite, Jr. 2012. Sightings of humpback whales on the Vitória-Trindade Chain and around Trindade Island. **Braz. J. Oceanog.** 60(3):455-459.

Sidorovskaia, N., B. Ma, A.S. Ackleh, C. Tiemann, G.E. Ioup, and J.W. Ioup. 2014. Acoustic studies of the effects of environmental stresses on marine mammals in large ocean basins. p. 1155 *In:* AGU Fall Meeting Abstracts, Vol. 1. Accessed in June 2015 at https://agu.confex.com/agu/fm14/meetingapp.cgi#Paper/10591.

Simard, Y., F. Samaran, and N. Roy. 2005. Measurement of whale and seismic sounds in the Scotian Gully and adjacent canyons in July 2003. p. 97-115 *In*: K. Lee, H. Bain, and C.V. Hurley (eds.), Acoustic monitoring and marine mammal surveys in The Gully and outer Scotian Shelf before and during active seismic surveys. Environ. Stud. Res. Funds Rep. 151. 154 p. (Published 2007).

Sivle, L.D., P.H. Kvadsheim, A. Fahlman, F.P.A. Lam, P.L. Tyack, and P.J.O. Miller. 2012. Changes in dive behavior during naval sonar exposure in killer whales, long-finned pilot whales, and sperm whales. **Front. Physiol.** 3(400). doi:10.3389/fphys.2012.00400.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. **Aquat. Mamm.** 33(4):411-522.

Southall, B.L., T. Rowles, F. Gulland, R.W. Baird, and P.D. Jepson. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar. Accessed in March 2015 at http://iwc.int/2008-mass-stranding-in-madagascar.

Southwestern Pacific OBIS. 2014. British Antarctic (""Terra Nova"") Expedition, 1910–1913. Southwestern Pacific OBIS, National Institute of Water and Atmospheric Research (NIWA), Wellington, New Zealand, 1679 records, Online http://nzobisipt.elasticbeanstalk.com/resource.do?r=terranova released on July 29, 2014. Retrieved from http://www.iobis.org.

Souza de Carvalho, M. and M.R. Rossi-Santos. 2011. Sightings of the bottlenose dolphins (*Tursiops truncatus*) in the Trindade Island, Brazil, South Atlantic Ocean. **Mar. Biod. Rec.** 4:e15. doi:10.1017/S1755267211000029.

Stevick, P.T., L.P. Godoy, M. McOsker, M.H. Engle, and J. Allen. 2006. A note on the movement of a humpback whale from Abrolhos Brank, Brazil to South Georgia. **J. Cetac. Res. Manage.** 8(3):297-300.

Stevick, P.T., M.C. Neves, F. Johansen, M.H. Engel, J. Allen, M.C.C. Marcondes, and C. Carlson. 2011. A quarter of a world away: female humpback whale moves 10,000 km between breeding areas. **Biol. Lett.** 7(2):299-302.

Stone, C.J. 2015. Marine mammal observations during seismic surveys from 1994–2010. JNCC Rep. No. 463a. 64 p.

Stone, C.J. and M.L. Tasker. 2006. The effects of seismic airguns on cetaceans in U.K. waters. **J. Cetac. Res. Manage.** 8(3):255-263.

Thompson, D., M. Sjöberg, E.B. Bryant, P. Lovell, and A. Bjørge. 1998. Behavioural and physiological responses of harbour (*Phoca vitu\lina*) and grey (*Halichoerus grypus*) seals to seismic surveys. p. 134 *In:* Abstr. 12th Bienn. Conf. World Mar. Mamm. Sci. Conf., 20–25 Jan., Monte Carlo, Monaco. 160 p.

Thompson, K., C.S. Baker, A. van Helden, S. Patel, C. Millar, and R. Constantine. 2012. The worlds' rarest whale. **Current Biol.** 22(21):R905-R906.

Thompson, P.M., K.L. Brookes, I.M. Graham, T.R. Barton, K. Needham, G. Bradbury, and N.D. Merchant. 2013. Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. **Proc. Royal Soc. B** 280:20132001. doi:10.1098/rspb.2013.2001.

Tolstoy, M., J. Diebold, L. Doermann, S. Nooner, S.C. Webb, D.R. Bohenstiehl, T.J. Crone, and R.C. Holmes. 2009. Broadband calibration of R/V *Marcus G. Langseth* four-string seismic sources. **Geochem. Geophys. Geosyst.** 10:Q08011. doi:10.1029/2009GC002451.

Tormosov, D.D., Y.A. Mikhalev, P.B. Best, V.A. Zemsky, K. Sekiguchi, and R.L. Brownell, Jr. 1998. Soviet catches of southern right whales *Eubalaena australis*, 1951–1971. Biological data and conservation implications. **Biol. Conserv.** 86(2):185-197.

Tougaard, J., A.J. Wright, and P.T. Madsen. 2015. Cetacean noise criteria revisited in light of proposed exposure limits for harbour porpoises. **Mar. Poll. Bull.** 90(1-2):196-208.

Tyack, P.L. and V.M. Janik. 2013. Effects of noise on acoustic signal production in marine mammals. p. 251-271 *In*: H. Brumm (ed.), Animal communication and noise. Springer, Berlin, Heidelberg, Germany. 453 p.

Tyack, P.L., W.M.X. Zimmer, D. Moretti, B.L. Southall, D.E. Claridge, J.W. Durban, C.W. Clark, A. D'Amico, N. DiMarzio, S. Jarvis, E. McCarthy, R. Morrissey, J. Ward, and I.L. Boyd. 2011. Beaked whales respond to simulated and actual navy sonar. **PLoS One** 6(e17009). doi:10.1371/journal.pone.0017009.

UNEP-WCMC (United Nations Environment Programme-World Conservation Monitoring Centre). 2015. Convention on International Trade in Endangered Species of Wild Flora and Fauna. Appendices I, II, and II. Valid from 5 February 2015. Accessed on 9 February 2015 at http://www.cites.org/eng/app/appendices.php.

van Helden, A.L., A.N. Baker, M.L. Dalebout, J.C. Reyes, K. Van Waerebeek, and C.S. Baker. 2002. Resurrection of *Mesoplodon traversii* (Gray, 1874), senior synonym of *M. bahamondi* Reyes, Van Waerebeek, Cárdenas and Yáñez, 1995 (Cetacea: Ziphiidae). **Mar. Mamm. Sci.** 18(3):609-621.

Van Waerebeek, K., A. Djiba, J.-O. Krakstad, A.S.O. Bilal, I.L. Bamy, A. Almeida, and E.M. Mbye. 2013. New evidence for a South Atlantic stock of humpback whales wintering on the northwest African Continental Shelf. **African Zool.** 48(1):177-186.

Vighi, M., A. Borrell, E.A. Crespo, L.R. Oliveira, P.C. Simões-Lopes, P.A.C. Flores, N.A. García, and A. Aguilar. 2014. Stable isotopes indicate population structuring in the southwest Atlantic population of right whales (*Eubalaena australis*). **PLoS ONE** 9(3):e90489. doi:10.1371/journal.pone.0090489.

Wade, P.R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. **Rep. Int. Whal. Comm.** 43:477-493.

Wang, M.C., W.A. Walker, K.T. Shao, and L.S. Chou. 2002. Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters. **Acta Zool. Taiwan** 13(2):53-62.

Waring, G.T., L. Nottestad, E. Olsen, H. Skov, and G. Vikingsson. 2008. Distribution and density estimates of cetaceans along the Mid-Atlantic Ridge during summer 2004. **J. Cetac. Res. Manage.** 10(2):137-146.

Wartzok, D., A.N. Popper, J. Gordon, and J. Merrill. 2004. Factors affecting the responses of marine mammals to acoustic disturbance. **Mar. Technol. Soc. J.** 37(4):6-15.

Wedekin, L.L., M.R. Rossi-Santos, C. Baracho, A.L. Cypriano-Souza, and P.C. Simões-Lopes. 2014. Cetacean records along a coastal-offshore gradient in the Vitória-Trindade Chain, western South Atlantic Ocean. **Braz. J. Biol.** 74(1):137-144.

Weilgart, L.S. 2007. A brief review of known effects of noise on marine mammals. **Int. J. Comp. Psychol.** 20(2):159-168.

Weilgart, L.S. 2014. Are we mitigating underwater noise-producing activities adequately? A comparison of Level A and Level B cetacean takes. Working pap. SC/65b/E07. Int. Whal. Comm., Cambridge, U.K. 17 p.

Weir, C.R. 2007. Occurrence and distribution of cetaceans off northern Angola, 2004/05. **J. Cetac. Res. Manage.** 9(3):225-239.

Weir, C.R. 2010. A review of cetacean occurrence in West African waters from the Gulf of Guinea to Angola. **Mammal Rev.** 40(1):2-39.

Weir, C.R. and S.J. Dolman. 2007. Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard. **J. Int. Wildl. Law Policy** 10(1):1-27.

Weir, C.R., J. Debrah, P.K. Ofori-Danson, C. Pierpoint, and K. Van Waerebeek. 2008. Records of Fraser's dolphin *Lagenodelphis hosei* Fraser 1956 from the Gulf of Guinea and Angola. **Afr. J. Mar. Sci.** 30(2):241-246.

Weir, C.R., T. Collins, I. Carvalho, and H.C. Rosenbaum. 2010. Killer whales (*Orcinus orca*) in Angolan and Gulf of Guinea waters, tropical West Africa. **J. Mar. Biol. Assoc. U.K.** 90(8):1601-1611.

Wells, R.S. and M.D. Scott. 2009. Common bottlenose dolphin *Tursiops truncatus*. p. 249-255 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Wensveen, P.J., L.A.E. Huijser, L. Hoek, and R.A. Kastelein. 2014. Equal latency contours and auditory weighting functions for the harbour porpoise (*Phocoena phocoena*). **J. Exp. Biol.** 217(3):359-369.

Wensveen, P.J., A.M. von Benda-Beckmann, M.A. Ainslie, F.P.A. Lam, P.H. Kvadsheim, P.L. Tyack, and P.J.O. Miller. 2015. How effectively do horizontal and vertical response strategies of long-finned pilot whales reduce sound exposure from naval sonar? **Mar. Environ. Res.** 106:68-81.

White, R.W., K.W. Gillon, A.D. Black, and J.B. Reid. 2002. The distribution of seabirds and marine mammals in Falkland Islands waters. Joint Nature Conservation Committee Report. 106 p. Accessed in June 2015 at http://jncc.defra.gov.uk/PDF/pubs02_Falklands.pdf.

Whitehead, H. 2002. Estimates of the current global population size and historical trajectory for sperm whales. **Mar. Ecol. Prog. Ser.** 242:295-304.

Whitehead, H. 2009. Sperm whale *Physeter macrocephalus*. p. 1091-1097 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Williams, A.J., S.L. Petersen, M. Goren, and B.P. Watkins. 2009. Sightings of killer whales *Orcinus orca* from longline vessels in South African waters, and consideration of the regional conservation status. **Afr. J. Mar. Sci.** 31(1):81-86.

Williams, R., S.L. Hedley, and P.S. Hammond. 2006. Modeling distribution and abundance of Antarctic baleen whales using ships of opportunity. **Ecol. Soc.** 11(1): 1. [online] Accessed in June 2015 at http://www.ecologyandsociety.org/vol11/iss1/art1/.

Williams, T.M, W.A. Friedl, M.L. Fong, R.M. Yamada, P. Sideivy, and J.E. Haun. 1992. Travel at low energetic cost by swimming and wave-riding bottlenose dolphins. **Nature** 355(6363):821-823.

Wilson, J.W., M.-H. Burle, and M.N. Bester. 2006. Vagrant Antarctic pinnipeds at Gough Island. **Polar Biol.** 29(10):905-908.

Winn, H.E. and N.E. Reichley. 1985. Humpback whale *Megaptera novaeangliae* (Borowski, 1781). p. 241-273 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 3: The sirenians and baleen whales. Academic Press, London, U.K. 362 p.

Wittekind, D., J. Tougaard, P. Stilz, M. Dähne, K. Lucke, C.W. Clark, S. von Benda-Beckmann, M. Ainslie, and U. Siebert. 2013. Development of a model to assess masking potential for marine mammals by the use of airguns in Antarctic waters. Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Wole, O.G. and E.F. Myade. 2014. Effect of seismic operations on cetaceans sightings off-shore Akwa Ibom State, south-south, Nigeria. **Int. J. Biol. Chem. Sci.** 8(4):1570-1580.

Wright, A.J. 2014. Reducing impacts of human ocean noise on cetaceans: knowledge gap analysis and recommendations. 98 p. World Wildlife Fund Global Arctic Programme, Ottawa, Ont.

Wright, A.J., T. Deak, and E.C.M. Parsons. 2011. Size matters: management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. **Mar. Poll. Bull.** 63(1-4):5-9.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. **Aquat. Mamm.** 24(1):41-50.

Würsig, B., T.A. Jefferson, and D.J. Schmidly. 2000. The marine mammals of the Gulf of Mexico. Texas A&M University Press, College Station, TX. 232 p.

Yazvenko, S.B., T.L. McDonald, S.A. Blokhin, S.R. Johnson, S.K. Meier, H.R. Melton, M.W. Newcomer, R.M. Nielson, V.L. Vladimirov, and P.W. Wainwright. 2007a. Distribution and abundance of western gray whales during a seismic survey near Sakhalin Island, Russia. **Environ. Monit. Assess.** 134(1-3):45-73.

Yazvenko, S.B., T.L. McDonald, S.A. Blokhin, S.R. Johnson, H.R. Melton, and M.W. Newcomer. 2007b. Feeding activity of western gray whales during a seismic survey near Sakhalin Island, Russia. **Environ. Monit. Assess.** 134(1-3):93-106.

Zerbini, A.N., A. Andriolo, M.-P. Heide-Jørgensen, J.L. Pizzorno, Y.G. Maia, G.R. VanBlaricom, D.P. DeMaster, P.C. Simôes-Lopes, S. Moreira, and C. Bethlem. 2006. Satellite-monitored movements of humpback whales *Megaptera novaeangliae* in the southwest Atlantic Ocean. **Mar. Ecol. Prog. Ser.** 313:295-304.

Zerbini, A.N., A. Andriolo, M.-P. Heide-Jørgensen, S.C. Moreira, J.L. Pizzorno, Y.G. Maia, G.R. VanBlaricom, and D.P. DeMaster. 2011. Migration and summer destinations of humpback whale (*Megaptera novaeangliae*) in the western South Atlantic Ocean. **J. Cetac. Res. Manage. (Spec. Iss.)** 3:113-118.